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CENTRAL STATION PRACTICE.

ONE of our English engineers recently stated in a discussion which took place on Captain Sankey's recent paper at the Institution of Electrical Engineers, that English engineers had established a certain design in their central stations which might in contra-distinction to Continental methods be called the English practice. It consists in providing their generating stations with a considerable number of high speed engines coupled to and driving their own dynamos direct. In most cases the favourite size appears to be 200 H.P., although, as was recently seen at the Naval Exhibition, a few sets had been made of 300 H.P. The practice appears to be the same whether the station is for direct or alternating current supply. To show how universal this practice is, we may point out that in London four central stations belonging to the Metropolitan Company, one to the St. James's and Pall Mall Company, three to the Westminster Company, two to the Kensington and Knightsbridge Company, one to the Notting Hill Company, one to the Chelsea Company, and one to Messrs. Gatti & Co., as well as the very complete plant supplied to the late Naval Exhibition, the two stations in Liverpool, one in Bradford, one in Brighton and one in Birmingham, all have their machinery arranged in this manner.

On the Continent of Europe, although there is no standard practice, yet that initiated by Messrs. Siemens and Halske for the great stations at Berlin has been very largely adopted, and has been imitated by several other large continental firms. In this case the units of supply consist of slow-running steam engines of from 300 to 500 H.P. driving large slow-speed dynamos mounted direct on an extension of the crankshaft of the engine. It would be interesting to study the causes which have led to such a wide divergence in practice. These slow-running engines and dynamos probably occupy four times the space and cost twice as much as the quicker running steam dynamos of equal power used in English practice. We think that one cause why high-speed steam dynamos have not found much favour on the Continent of Europe is, that their use was initiated by Edison in the original "Jumbo" type of steam dynamo sent to England and to various parts of the Continent in 1882. The simple type of high-speed engine then used was not an economical one, and the Continental engineers compared its extravagant consumption of steam with the highly economical results they obtained from the slow-running engines made by Van der Kirchove at Ghent, Kühn in Germany, and Sulzer in Switzerland, and other makers of like celebrity. The only other high-speed engines which have found their way to the Continent were a few of the Westinghouse type, and some of the earlier engines made by Messrs. Willans, but none of these showed such striking advantages as to make the Continental engineers adopt them. The dynamo designers had, therefore, to adapt

the design of their machines to the requirements of the engine builders, and the large ring armatures introduced by Messrs. Siemens and used in the Markgrafenstrasse central station in Berlin, were the first examples of the kind. These splendid specimens of dynamos, driven by Van der Kirchove's engines, although extremely costly compared with their output, at once commanded admiration, and established a type which could safely be copied. Hence the majority of Continental central stations are filled with machinery of this class, and up to the present time the Continental engineers, who have been principally trained in the German school which centred itself at Berlin, can see no good in any design which does not embody these principal features.

The forerunner of our present English type of central stations was, curiously enough, carried out on the Continent. We refer to the one designed conjointly by Mr. Monnier and Mr. Crompton for the Imperial and Continental Gas Association at Vienna. For this station, Mr. Crompton convinced Mr. Monnier that the combination of the Willans engine, driving a dynamo direct at from 300 to 400 revs. a minute, was one which presented great advantages. Not only is the plant exceedingly economical in fuel and oil, but it is also easily handled, and occupies a minimum of space. The results obtained at Vienna were so encouraging, that Mr. Crompton employed the same class of machinery for the Kensington station. Messrs. Gatti followed with theirs at the Adelphi Theatre, and since that time the results have been so undeniably satisfactory, that designers of dynamos and others have vied with one another in seeing who could produce the most satisfactory and compact combination of dynamo with the Willans engine. Not the least contributory to this have been Messrs. Willans themselves, who, with considerable foresight at a very early date, established at their Thames Ditton works a set of testing apparatus, by which every steam dynamo, before it left their works, could be subjected to tests of long duration, during which the actual consumption of fuel and water could be accurately measured, and the proportion which the useful E.H.P. bears to the I.H.P. in the engine cylinders could be noted.

The result has been a steady and gradual improvement, not only in the engines produced by Messrs. Willans and others, but also of the dynamos driven by these engines. There is little doubt that this continuous testing of every type of dynamo which had to be fitted to a Willans engine has had a very salutary effect in eliminating patterns of dynamo machines which, at one time, were fondly believed in by their owners, but which first showed their radically bad effects when submitted to the efficiency test. Another result has been that nearly all the English stations are provided with plant, the economic efficiency of which can be estimated very closely. Mr. Willans, Mr. Crompton and others inform us that these results are actually borne out in practice in the central stations themselves, and they explain that the discrepancies which exist between the consumption of fuel and water measured on the trial full load runs, and the actual consumption of fuel and water, shown by the books of the company over extended periods, are entirely attributable to partial loading and to special causes which, in themselves, are extremely interesting.

Now that attention has been called to these points, it is to be hoped that English engineers will see their way to reduce these losses, and in so doing make English central station practice more nearly approach to ideal economic efficiency. It would be extremely interesting to know how the results obtained on the Continent with their form of machinery differ from those obtained in England. We have not heard that any of the Continental engine builders or dynamo makers possess appliances for the accurate testing of their plant which can give the figures furnished by Messrs. Willans's tests. In fact, we cannot find that any such tests have ever been published. The nearest approach to anything of the kind were some figures furnished by Prof. George Forbes in his description of the machinery used in the Berlin central station, but no one has even given the quantity of coal or water used per E.H.P. or unit. In default of such figures we are necessarily quite in the dark when we attempt to compare the merits of the two systems from an economical point of view, and this is to be regretted. From the few facts which have come to our knowledge, we believe that if accurate data could be obtained from the existing continental stations, English engineering practice would have nothing to lose by the comparison; and we put it to those of our continental readers who are desirous of adding to the general stock of knowledge on this subject to communicate to us any such data as they think will throw a light on this highly interesting question.

Another point which is of interest is the best size of steam dynamo for a large central station. As we have said above, our English engineers have usually preferred to divide their station into units of 200 to 300 H.P. each, whereas on the Continent they appear to prefer from 300 to 500 H.P. each, although in some few cases sets of 1,000 H.P. each have been put down. The smaller size of the English unit does not appear to be connected with the engines, for we understand Messrs. Willans are quite prepared to furnish them of 500 or 600 H.P., if called upon to do so; nor does it lie with the dynamo makers, who are equally ready to supply dynamos of this size. In all probability the cause determining the size of the unit in England must be sought for in the fact that few districts that have been granted provisional orders are likely to require more than from 2,000 to 3,000 H.P. for working them, and such an output can be very conveniently divided between eight or ten engines of 200 and 300 H.P. each. No doubt in Berlin the case was widely different. The enormous amount of restaurant and hotel lighting crowded into a comparatively small part of the town, and within a short radius of the central stations, has made the lighting much more dense than it is likely to be in London during the present generation, or, at all events, until Londoners are educated to a more lavish use of light than is at present the case. Even in the extremely densely lighted districts served by the St. James's Company it does not appear that the designers of that station would have improved matters by filling their station with a smaller number of engines of larger power than those they at present employ.

Specifications of Insulated Conductors.

A CORRESPONDENT writes:—"I do not agree with the opinions expressed by Mr. Preece about specifying megohms per mile being meaningless, or about the obvious advantages of the proposed specific unit. In the views previously expressed by the REVIEW stress has been laid on the importance of specifying resistances, and testing to see that the cables come

up to specification. My opinion is that specifying megohms per mile, although not perfect, is the most convenient plan, as the results of check tests are obtained in those units, and the first thing to be done is to get all buyers to take the trouble to test their cables; for, so long as matters go on as at present, when only one man in twenty ever thinks of finding out whether a cable comes up to specification or not, it is very little use elaborating the latter. Many people will say 'If Mr. Preece says it is meaningless, what is the good of bothering about the test at all?' and they will stop there without trying to substitute any other mode of specifying or testing the cable."

Condensers in Electric Lighting.

THE use of condensers which has hitherto been practically confined to telegraphic working, has of late years shown signs of a development for electric light purposes. For continuous current systems but little use could be made of such apparatus, the storage capacity $\left(\frac{\text{voltage} \times \text{capacity}}{2}\right)$ being insignificant in comparison with bulk. For alternating current working in connection with transformation the use appears to be more hopeful, but it is not yet clear what decided advantages may be anticipated over ordinary transformers except as regards avoidance of hysteresis; this, Mr. Swinburne points out in a first article on the subject in *Industries*. For other purposes more may be expected; condensers can be used to supply magnetising, or exciting currents to all sorts of machinery, and also to apparatus that takes lagging currents. In cases where arc lamps are run off a 100-volt circuit, with a choking coil in series, condensers placed in shunt to the choking coils and lamps, counteract the loss which would otherwise result from idle currents. As regards bulk, Mr. Swinburne points out that a cubic foot of condenser will take about 2,000 volts and 5 ampères, or 10,000 apparent watts.

Practical Notes on the Reflecting Galvanometer and its Accessories.

IN an article under this title, by Mr. J. D. Bishop, which appeared in the *Electrical Review* of New York, the writer whilst making some excellent practical remarks on the general subject he is dealing with, makes the following statement:—"The makers of first-class galvanometers are but few in Europe, and there are none at the present day in the States, although enormous progress has been made by the American manufacturers of late years. But, although they have successfully imitated the appearances and external design of the best European models, they show far inferior results. But the inferiority of the results obtained by these home-made instruments is nothing compared with their uncertainty, and an uncertain instrument is simply worse than useless. Of course, the time is not far distant when this inferiority will disappear in galvanometers, as it already has in condensers, but we have to deal with the present moment only. I will give a few of the faults found in one of these beautifully home-made imitations. It was believed by its owners to be a magnificent instrument. In finish and design it could not be distinguished from the original it was copied from. Very minute instructions how to set it up accompanied it, and its resistance was certified to be, at 65° (F. or C. not stated), 6,345·22 ohms. The hard rubber base was too thin and had warped. One of the bevelling screws fitted so tightly that it had to be removed and loosened. Only in one of the levels could the bubble be got to stop in the centre of its tube. The little steel needles had not been made perfectly straight, consequently, when the shellac by which they were fastened to the back of the mirror dried their spring bent the mirror out of shape. The lower set of magnets were fixed on a talc disc, consequently, its rough edge was always being caught by the rough surface of the blackened cell. The needles also were so badly tempered that their magnetism was never constant, consequently, the deflections were unreliable. The centre of gravity of the whole needle and mirror suspension was so high that it was impossible to secure steadiness. The front glass, instead of being of the purest and whitest kind, was inferior and threw a false spectrum or spot on the scale, sometimes almost as plain as the spot reflected from the mirror itself. The centre of gravity of the whole instrument was placed so high that its base board had to be extended to cure its top-heaviness. None of its shunts were correct at any temperature. As a piece of highly finished work it was a credit to the mechanic who lacquered and covered it all over with beautiful spiral flourishes; as an astatic reflecting galvanometer it was a dead failure. And its cost was a little more than that of a good Siemens or Elliott (London), or Carpentier (Paris)." Whilst we are personally able to speak from long experience of the almost uniform excellence of the instruments manufactured by well known London firms, we could hardly have imagined that our American friends were so badly off as Mr. Bishop indicates. At the same time it is gratifying to find that our own makers' work is appreciated, although, indeed, seeing the monopoly which submarine telegraphy has held in this country it is not surprising.

Savory and Moore *v.* the London Electric Supply Corporation.

THIS case, says the *Times* report, "illustrated the 'great' danger arising from the erection of electric light supply works in the heart of a city or town, or in contiguity with other buildings," and was an action to restrain the corporation from using certain buildings adjoining the plaintiffs' premises as an electric light distributing station. As the result of Mr. Justice Kekewich's judgment, the plaintiffs were granted the injunction, and the reinstatement of the premises as a distributing station is interdicted. The judgment practically states that it is not clear that when the corporation's plans are completed above the basement, there will be no danger of a repetition of the disaster which recently took place. It appears that the corporation were called upon to give an undertaking that the necessary precautions should be taken to prevent further accidents, and that they did not offer any obligation to do so, but only expressed their intention of seeing to the matter; under the circumstances, therefore, it is not surprising that the action was brought, and that the judgment should have been given against the defendants. We must protest against a law report commencing as if the writer were penning his own opinions, but at the same time a correspondent's fears that electricity works will now be practically banished from the city seem to us to be groundless.

The Crystal Palace Exhibition.

THE list of exhibitors who have asked for space in the Crystal Palace is, as will be seen from a glance at our other columns, an imposing one, both in numbers and importance. A contemporary recently gave vent to the following remarkable utterance under the heading of "Advice *re* the Palace Exhibition." "If we say that we intend to describe this exhibition from start to finish—and we do say so—it will be found that our contemporaries are bound to do so likewise. They dare not lag behind in such a race." We do not use these now historical words in publishing this list, but we simply hope that it may be found serviceable to many of our readers. So far as we are concerned we would remind the editor of our contemporary—and we are sure he will appreciate it—of the remark once made by an umpire to Mr. Bush, formerly well known in the Gloucestershire eleven, and to be found in a well known work on cricket: "This is not a running match, Sir! You are here to play cricket."

REACTIVE COILS.*

By OLIS K. STUART.

SINCE the sudden and comparatively recent enormous expansion of alternating electric lighting commercially, the writer has been asked by scores of persons to explain the "principle" of reactive coils. As these requests have most frequently been made by superintendents of central stations and others directly interested in the operation of alternating current apparatus, it is believed that a brief explanation of the actions of such devices will be of interest and value to not a few readers.

An alternate current transformer consists usually of a magnetisable core, around which are placed two coils of conductors, having no electrical connection with each other or with the core. If now we pass a direct or continuous current of electricity through one of these coils, the appreciable effects to be noticed will be, first, the magnetisation of the core, and, second, the heating of the coil through which the current is passing. The lines of force will retain the same direction or polarity so long as the current is maintained in the same direction in the coil; but if the direction of the current be changed, the lines of force in the field will be found to be directed oppositely to the previous lines; and if we again change the direction of the current in the coil, the lines of force will again take the direction or polarisation they had at first. If we alternate the direction of flow of the current in the coil, we thereby alternate the polarity of the magnetisation of the core.

A principle enunciated by Faraday was that if a conductor be moved across or through a magnetic field, a current of electricity would be generated in the conductor; it was Prof. Elihu Thomson, I believe, who first stated the principle backwards—that if a magnetic field cut or be moved across a conductor, a current of electricity would be generated in the conductor.

In the case of the apparatus above mentioned we have a stationary field of magnetism, except at the very start of the current, so long as a continuous current is maintained; and consequently no current is developed in the second coil except at the very instant of start of the current through the first coil. When the direction of the current is changed, there is another instant of moving field, and another impulse of current is sent through the second coil. And if these alternations are very rapid, the second coil will receive correspondingly rapid impulses of current alternating in direction, as is the case with the secondary coil of an alternate current transformer. These impulses of current in the secondary coil not only alternate with the alternation of the current in the first or primary coil, but each impulse of the former is found to be in the direction opposite to the corresponding impulse of the latter. That is, an impulse of primary current generates a magnetic field which sets up a current in the secondary, of opposite polarity to the primary current.

We are now ready for our reactive coil. In its simplest form it consists merely of one coil of a conductor wound around a magnetisable core. A direct or continuous current sent through this coil would simply magnetise the core and heat the coil itself. Reversing the direction of the current in the coil would apparently have the effect merely of reversing the polarity of the magnetism in the core. But we have here a moving field of magnetism in proximity to a conductor, and this moving field *must* act upon the coil, and in a manner opposite to the original impulse of current. The one coil serves as both primary and secondary of a transformer. The counter effect in the coil is named a counter-electromotive force, and it acts as a block to the progress of the first or primary current. The primary current in the coil generates a moving magnetic field which reacts upon the coil, setting up a counter-electromotive force, and cutting down the current in proportion. In the case of direct or continuous currents which are sent through the coil first in one direction and then in another, the counter-electromotive force is but momentary at the very start of each impulse of current; but with rapidly alternating currents the counter-electromotive force is evidently as constant as the impressed electromotive force or primary current.

A reactive coil placed directly in the circuit of an alternating system, therefore, can be made to control the amount of current going over the system, and this is its chief use. Specially designed reactive coils are used constantly by the Thomson Electric Welding Company for controlling electric welding transformers, and similar devices are familiar to all electrical engineers. But probably the most interesting application of this valuable apparatus has recently been made by Mr. Elias E. Ries in the Ries regulating socket, which is now attracting so much attention.

In this socket Mr. Ries has simply placed a very small reactive coil so connected to a series of contacts that, by means of a movable arm attached to an ordinary socket-key, a relatively small or large amount of current may be admitted to the filament, and the brilliancy of the light thereby be governed at will. An incandescent lamp, on an alternating current circuit, is thus placed upon an equal footing with gas, so far as the power of governing the light of individual burners is concerned. And that the method is very economical will be evident to anyone who reflects that if the current does not pass through the coil, it is not used; in fact, is not generated. The total energy consumed in the lamp would be represented by the product of the voltage and the current actually supplied to the filament. And this is true in all other cases where reactive coils are employed as regulators.

* New York *Electrical Engineer*.

THE MEASUREMENT OF SMALL DIFFERENCES OF ELECTROMOTIVE FORCE.

By H. R. KEMPE.

HAVING recently had occasion to compare the relative electromotive forces of several standard cells in order to determine to what extent they differed in value, I found the following arrangement, which is merely a particular way of carrying out Wiedemann's method, to give very satisfactory results and to be at the same time very easily made.

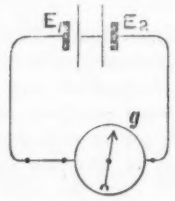

FIG. 1.

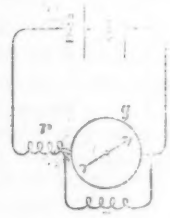

FIG. 2.

The cells are first joined up in opposition, as shown by fig. 1, through a Thomson galvanometer, g, and the deflection, d, which is due to the difference in electromotive force between the two cells, is noted. One of the cells, say E_2, is now reversed (fig. 2), and, in order to keep the deflection within the range of the scale, the galvanometer, g, is shunted with a shunt, s, a compensating resistance, r, of the value necessary to keep the resistance of the circuit unaltered, being inserted at the same time; the deflection, d, is then noted, and we have

$$\frac{E_1}{E_2} = \frac{n\,d + d_1}{n\,d - d_1}, \qquad [A]$$

where n is the multiplying power of the shunt.

The great point in this method of testing is the high degree of accuracy with which the relative values of E_1 and E_2 (when they do not differ materially), can be determined.

For example—supposing the deflection obtained in the case of fig. 1, to be 1 division and in the case of fig. 2, to be $200 \times \frac{1}{1{,}000} = 200{,}000$ (a result which would be obtained with a galvanometer of 5,000 ohms resistance if the adjustment of the instrument were such that one cell through 10,000 ohms with the $\frac{1}{1{,}000}$ shunt gave 50 divisions), then

$$\frac{E_1}{E_2} = \frac{200{,}000 + 1}{200{,}000 - 1} = 1{\cdot}00001$$

i.e., a difference of 1 in 100,000.

It might be objected that when the cells are joined up as shown by fig. 2, their electromotive forces would run down, this, however, is not of material consequence (even if it could take place with a galvanometer which has a resistance of 5,000 ohms or more), for a fall in force of say one per cent. under these conditions would only mean an error of one per cent. in the value which in the above example is expressed by ·00001, and not that percentage of error in the value expressed by 1·00001.

As the chief value of the method is to determine small differences of force, we may simplify equation [A] in the following manner :—

Since [A] is derived from the equation

$$\frac{E_1 - E_2}{E_1 + E_2} = \frac{d_{,}}{n\,d}$$

and since E_1 and E_2 are very nearly equal, so that we may put $E_1 = E_2$, therefore we get

$$\frac{E_1 - E_2}{2\,E_2} = \frac{d_{,}}{n\,d}$$

therefore

$$\frac{E_1 - E_2}{E_2} = \frac{2\,d_{,}}{n\,d}$$

therefore

$$\frac{E_1}{E_2} - 1 = \frac{2\,d_{,}}{n\,d},$$

that is,

$$\frac{E_1}{E_2} = 1 + \frac{2\,d_{,}}{n\,d}.$$

Or, if we prefer to express the difference as a percentage, then we have

$$\frac{2\,d_{,}}{n\,d} = \frac{x}{100} \text{ of } 1$$

or,

$$x = \frac{200\,d_{,}}{n\,d};$$

thus in the example taken, the percentage of difference between the two cells would be

$$x = \frac{200 \times 1}{200{,}000} = \tfrac{1}{1000}\text{th per cent.}$$

THE ACCUMULATOR IN COMMERCIAL WORK.

THE accumulator, as a factor in central station regulation, has hardly received in this country the attention which it undoubtedly deserves, and as a consequence, in this particular field, our European brother electricians are ahead of us.

Several reasons for this state of affairs might be cited, chief of which, perhaps, has been the uncertainty hitherto prevailing with regard to patent rights, and the somewhat exaggerated claims as to efficiency, durability, non-excessive discharge rate, &c., put forward by certain manufacturers.

In its application to the problem of electric traction, however, the secondary cell has been subject to more extensive and varied experiment here than abroad.

The storage battery, possibly more than any other piece of electrical apparatus in commercial use, demands *intelligent* supervision and management, in order to get from it the best possible results, and yet there is prevalent a too general feeling of distrust in a secondary battery which is not wholly unwarranted, unless they are unwisely expected to take care of themselves.

The number of modifications of the leading types, as to form of grid, is very large, and a study of the variations of no mean interest or importance.

Having had occasion, in the course of business, writes Mr. J. Stanford Brown, in the *Electrical World*, to look up a point with regard to the patentability of a certain variation of form, the following check list of references is presented to the *Electrical World*, in the hope that it may save valuable time to some one having to hunt up the descriptions of any particular make of cell.

The list is, of course, far from complete, for having found out the required information the matter was for the moment laid aside.

American periodicals are given in small capitals and the English in capital letters, thus :

E. W. THE ELECTRICAL WORLD, New York.
E. E. *The Electrical Engineer*, "
E. R. " *Review*, "
E. A. " *Age*, "
E. P. *Electric Power*, "
W. E. *Western Electrician*, Chicago.
E. E. *Electrical Engineer*, London.
E. R. " *Review*, "
L. E. *The Electrician*, "

The abbreviations used for other periodicals explain themselves to those familiar with electrical literature.

ACCUMULATORS.—DESCRIPTIONS.

Alkaline, see Commelin, Elwell & Cie.
"Atlas," see Hering.
"Anglo-American," see Sorley.
Bailly ("Phœnix"), E. W. X., 7.
Bandsept.—E. E. XII., 427.
Barbier (vs. Woodward).—E. R. XXXIV., 106.
Barber-Starkey.—L. E. XXV., 719; E. R., XXVI., 437; E. E., VI., 392.
Barker (ZnPb, peroxide).—E. W. XIV., 197.
"B. T. K.," see Beeman, &c.
Beeman, Taylor & King.—L. E., XII., 395; XIII., 118; XIV., 51, 499; E. W. VI., 7.
Blanc & Co.—E. E. IV., 99.
Bradbury & Stone.—E. E. VII., 433: E. W. XVIII., 98.
Brush.—E. E. III., 476; L. E. XII., 294; XXVI., 474.
"Cambridge," see Hatch.
Carpenter.—E. W. XIV., 276.
Cély (Sarcia).—E. W. XVIII., 385.
Commelin, Desmazures & Bailhache (Cu Zn alkaline).—E. W. XIV., 177; XVII., 19; E. E. III., 416; E. E. XII., 548; L. E. XX., 13; XXII., 302; XXVI., 195.
Correns.—E. E. XII., 497; E. W. XVIII., 251; L. E. XXVII., 592; E. R. XXV., 99; XXIX., 268.
Currie (lead chloride).—E. R. XXVII., 477; E. E. X., 375; XI., 72, 268.
Desmazures.—See Commelin.
Dey (experimental), E. E. XI., 162; L. E. XXVI., 506.
Dujardin.—E. E. VIII., 428.
Eickemeyer.—E. W. XIV., 304; L. E. XXIV., 135.
Electrical Acc. Co., N. Y.—E. W. XIV., 102; XVIII., 385.
Elwell & Cie (CuZn, alkaline).—E. W. XVIII., 385.
Elwell Parker (+ Planté — Faure).—L. E. XI., 130; XII., 214, 255; XIV., 187; XV., 42; XVI., 212; XXII., 735.
"E. P. S."—See Electrical Power Storage Company.
Electrical Power Storage Co. ("E. P. S.")—E. E. VI., 313; VIII., 428; L. E. XIII., 320; XIX., 209; XXI., 90; XXII., 735; XXVI., 5; E. W. XVIII., 385.
Entz.—See Waddell.
Epstein.—E. E. VII., 480.
Ernst.—E. E. XI., 158.
Farbaky & Schenck.—E. W. VIII., 62; L. E. XVII., 190.
Faure (1880),—E. W. VI., 7; E. E. VIII., 409; L. E., XXI., 218.
Faure-Sellon-Volckmar.—L. E. XII., 306; XIII., 59, 435; E. R. XXV., 469; E. W. XVIII., 388.
F. S. V.-Gadot.—L. E. XIII., 290.
Fitzgerald (Lithanode).—E. W. VII., 198; L. E. XXVII., 691; E. R. XXIX., 310.
Gadot.—L. E. XIV., 142; XXI., 605; E. W. XVIII., 385.
Garassino.—E. W. XVIII., 385.
Gaudini.—E. R. XXIX., 323.
Gibson.—E. R. XXIV., 23; XXVIII., 438; L. E., XXI., 103.
Glaesener.—L. E. XV., 200.
Hagen.—E. W. XVIII., 251, 385; E. E. VI., 566.
"Hair."—L. E. XVIII., 153.
Hatch ("Cambridge").—E. E. XI., 184; E. W. XVII., 2, 46.
Hedges.—L. E. XIX., 485.
Hering.—E. E. IX., 447; E. W. XV., 403, E. E VI., 9.
Hering, Abdank-Abakanowicz, d'Arsonval & Picou.—E. E. XI., 299 L. E. XXVI., 484; E. R. XXVIII., 207.
Hollingshead.—E. E. X., 256.
Howell.—L. E. XX., 695, 727, 751.
Huber.—E. W. XVIII., 385.
James.—L. E. XXVI., 751.
Jarman.—E. E. X., 470; E. R. XXVIII., 224; XXIX., 46.
Johnson.—E. R. XXVII., 446.
Julien.—E. W. IX., 240; XVIII., 252, 385; L. E. XX., 192.
Kabath.—L. E. IX., 61; XI., 436.
Kalisher.—L. E. XV., 41.
De Khotinsky.—E. E. XII., 534; E. W. XVIII., 252; 385.
Kirchhoff (1861).—L. E XVII., 111; E. W. VII., 257, 260.
Knowles-Julien.—E. W. XIII., 160; XIV. 34.
" " (anticipated by Sellon).—L. E. XXIII., 388.
Lalande & Chaperon.—(CuZn, alkaline).—E. W. XVIII., 385.
Laurent-Cely.—E. E. IX., 477; E. R., XXVII., 277 L. E. XXI., 320 XXV., 82, 108.

"Lithanode."—See Fitzgerald.
Lloyd & Paxton.—St. Ry. Jrl. VII., 349.
Logan.—E. W. XIV., 426.
Lugo.—E. E. XII., 261; E. E. III., 106.
Macracon (Planté—Faure).—Sci. XIII., 195.
Main (ZnPl, "River and Rail").—E. E. X., 132; XII., 548; E. W. XVI., 54.
Marx (Fe).—E. E. IX., 363, 435; E. E. VIII., 124.
McLaughlin.—E. W. XVI., 249, 289.
Meserole (Zn).—E. E. XII., 548; E. W. X., 16.
"New Era."—E. W. XVIII., 195.
Niblett (solid).—E. E. VIII., 80.
"Oerlikon."—See Schoop.
Parod.—L. E XIV., 175; E. W. V., 49.
Payer ($PbCl_4$).—E. W. XIV., 368.
Phillips.—See Waddell.
"Phœnix."—See Bailly.
Planté (1860).—E. W. V., 49; VI., 7; VII., 257; XIII., 192; XVIII., 385; L. E. XII., 255; E. R. XXVII, 716.
Pollak.—E. E. VIII., 428; IX., 309; XII., 534; E. W. XVIII., 252, 385; E. R. XXVI., 377.
Pumpelly.—E. W. XIV., 426.
Reynier (Zn).—E. W. XII., 548; L. E. XIV., 303; XXV., 186; XXVI., 113; E. E. X., 666; E. W. VIII., 102; X., 102; XVI., 440; XVII, 206.
Schoop ("Oerlikon," gelatine).—E. E. VIII., 428; XII., 534; E. W. XIV., 33; XVIII., 252, 385; L. E. XXIII., 187; XXV., 245, 253.
Sellon.—See Faure-Sellon-Volckmar.
Slattery.—El. Ry. Advr., II., 45.
Smith-Cornelius.—L. E. XIX., 216.
S. A. p. l. T. E. d. M.—E. E. VIII., 428.
Sorley ("Anglo-American").—E. W. XIV., 50, 140.
Starkey.—See Barber-Starkey.
Starr (Planté).—L. E. XIV., 29.
Tatham.—E. E. III., 132; E. W. XIII., 158.
Tamine.—E. W. X., 76.
Tommasi (Multitubular).—E. R. XXIX., 497; E. E. X., 671; XII., 555; Elec. Ent. II., 382; L. E. XXVII., 681.
" (anticipates Woodward), L. E. XXVI., 130, 182,
Tudor (Planté).—E. E. XII., 497; E. W. XVIII., 251, 385; L. E. XXI., 165, 180, 490; XXVII., 592; E. R. XXIX., 268.
Van Gastel.—E. W. IX., 191; L. E. XXIII., 536.
Waddell-Entz—Phillips (Cu oxide, alkaline).—E. E. X., 537; E. W. XV., 190; XVII., 354; XVIII, 385; L. E. XXVII., 647; E. R. XXVIII., 675.
Washburn.—E. E. XI., 546.
Winkler.—E. E. XII., 108.
Woodward.—E. W. XIII., 177; E. E. VII., 82.
" (anticipated by Tommasi).—L. E. XXVI., 130, 182.

THE LAW OF MAXIMUM EFFICIENCY OF ELECTRIC MOTORS.*

BY C. O. MAILLOUX.

IN the very interesting article on his new method of operating motors, published in the *Engineer* of November 25th, Mr. H. Ward Leonard enunciates a so-called new law of efficiency which is, unfortunately, not free from objections.

Mr. Leonard states his "law" as follows:—

> Vary the voltage as the speed desired,
> Vary the ampères as the torque required.

The now classical researches and historic experiments of Marcel Deprez have long since consecrated these two statements, which are to be found, more or less amplified and elaborated, in the writings of Du Moncel, Froelich, Ayrton and Perry, Silvanus Thompson, and others. The claim to novelty evidently rests upon the "combination," or, rather, the opposition of the two statements to make a law. It so happens, however, that the combination does not formulate *a* law, but merely states, somewhat awkwardly, some of the conditions favourable to *the* law—Siemens's law of efficiency. The awkwardness and vagueness of diction is made readily apparent by the fact that a good illustration of the "law," as worded, obtains in the now common practice of regulating street car motors by means of a variable resistance in the circuit. The manipulation of this resistance at the time of starting, or afterwards, *causes the ampères to vary as the torque* required. It also causes the *voltage* (available at motor terminals) *to be varied as the speed desired*. This example strictly conforms to the *letter* of Mr. Leonard's law of efficiency. That it does not conform to its *spirit* as well is shown by the deprecatory manner in which Mr. Leonard himself refers to the efficiency obtained and obtainable in such cases.

While the law is evidently more general and far-reaching, in certain directions, than its author intended, in other directions it does not reach as far as might be desired or expected. Mr. Leonard furnishes a good illustration of this deficiency, though apparently without noticing that he has, in so doing, wandered from the territory "covered" by his rule. He says:—

"If we have a train of, say, three cars, so that we have six motors, we can start from rest with sufficient smoothness by placing all six armatures in series, which will give us something less than one-sixth speed as the first step. Then we can place three in series with two multiples, which gives us one-third speed. Next, two in series with three multiples, which gives us full speed. Under such conditions we can dispense with the small converting plant altogether."

It is scarcely necessary to point out that in this case the torque and speed are both varied or regulated, not by following Mr. Leonard's "law," but by varying the *counter-electromotive force*. The circuit potential available to the motors may remain constant. The current, on the contrary, will not remain quite constant for all groupings. It is apparent, therefore, that Mr. Leonard's law would be most useful when supplemented by a key to, or list of, its exceptions.

The present writer sees no necessity for discovering new laws to replace the one law of efficiency (Siemens's) which we already have, so long as this law is found sufficiently comprehensive and general to include and cover, satisfactorily, all cases yet referred to it. According to this well-known law, the efficiency (K) of an electric motor is the ratio of its counter E.M.F. (e) to the direct E.M.F. (E) of the current supplied to it, or, algebraically:

$$K = \frac{e}{E}.$$

A mere glance at this equation suffices to show three ways in which the efficiency (K) can be enhanced in any given case. 1. By lowering E. 2. By raising e. 3. By doing both simultaneously. These might be called the three *conditions* which influence efficiency, and might be embodied in the following rule which is a corollary from Siemens's law.

"Vary either the direct or counter-electromotive forces, or both, so as to keep them at all times as close to each other in value as possible."

Mr. Leonard's apparatus and his "law" conform to this rule by taking advantage of the *first* condition. The case quoted of the six motors variously grouped corresponds to the *second* condition. He gives no instance of methods corresponding to the *third* condition.

The present writer first realised the bearing and importance of the above "conditions" in 1886. In 1887 he operated a storage battery car in New York city in which the speed regulation was effected partly by grouping the batteries, partly by grouping the two motors, thus taking advantage of *all three* conditions. The car operated by the writer in Washington in 1890 was also regulated in a way to profit by all three conditions.

The writer has also tried the plan of regulating by using a motor whose speed is reduced by means of gearing adapted to giving widely variable speed ratios. In this case the torque is largely, or wholly, independent of the current, being governed mainly by the ratio of speeds. The regulation is effected by the counter E.M.F. lowering or rising according to the current needed for the work to be done, (condition 2). This method, though not yet reduced to the desirable simplicity or perfection of mechanical form and feature, is, nevertheless, a promising one, and likely, on the whole, to furnish us eventually the desired constant efficiency under varying loads and rates of work in a more simple and less round-about manner than is the converter method of which Mr. Leonard's is the prototype.

Without pretending to discuss here the merits of Mr. Leonard's ingenious method and arrangement, which doubtless will not be without its sphere of applicability and usefulness, it is perhaps interesting to point out that in the case of an electric car, a continuous current converter such as described by Mr. Leonard, would add some 1,500 lbs., and *two commutators* to the car. The objections to the two extra commutators would "weigh," if anything, *more* than the double machine. The writer has himself devised methods of regulation employing continuous current converters in connection with ordinary *series motors*. He has always been too diffident and timid, however, to broach the question of the

* New York *Electrical Engineer*.

two extra commutators either to the street railway manager or the motor man, both of whom would more willingly entertain a proposition to reduce, instead of to increase, the number of commutators.

One of the interesting and important conclusions to which the study of the equation of efficiency leads is that there can be no efficiency unless there is a counter E.M.F. (*i.e.*, when $e = 0$, then $\kappa = 0$). Now, since we have no commercial way of causing counter E.M.F. in motors except by motion of the armature, it follows that when the motor is not in motion, we have usually $e = 0$, and the efficiency, κ, consequently $= 0$. This consequence is one from which no system of continuous-current motor operation is exempt. One can, it is true, reduce E to the lowest value needed to produce in the motor the current necessary for the torque desired. The energy thus spent (E C) is what Marcel Deprez designated some years ago as the "cost of the torque (prix de l'effort statique)." This "cost of the torque" always corresponds, as shown by Deprez, to the C^2 R loss in a series motor. It practically does also in other motors.

The writer may take some future occasion to describe some of the methods of regulation proposed and tried by him in his endeavours to comply with the above conditions, influencing efficiency.

IS ACTINISM A SPECIES OF ELECTROLYSIS?*

By Prof. EDWIN J. HOUSTON.

THAT the action of sunlight on growing plants should partake of the nature of electrolytic decomposition is, perhaps, to be inferred from the general views now held in accordance with Hertz's theory as to the identity between sunlight and electro-magnetic radiations of waves.

As far as our knowledge of growing plants extends, the oxygen which results during the general process of deoxidation, under the influence of sunlight, appears to be evolved mainly from the non-illumined or darker face of the leaf, while the carbon, or the less highly oxidised carbon compounds, which are utilised by the plant for the production of its woody fibre and woody tissues, though afterward deposited in all parts of the leaf, are probably mainly liberated at or near the illumined face.

If these facts be as above mentioned, the decomposition in the leaf, under the action of sunlight, of the carbonic acid or its derivative compounds probably partakes of the nature of electrolytic decomposition.

In this direction I would suggest the following lines of investigation, namely :

1. To ascertain experimentally whether their exists on the opposite faces of a growing leaf, when exposed to the full action of sunshine, a difference of electric potential resulting from the polarisation which always accompanies electrolytic decomposition ; and if it be so, what is the nature of such polarisation.

If such differences of potential actually exist, it would, of course, follow that the illumined face of such leaves, under polarisation, would be mainly electro-negative, since it is at or near this face that the carbon or less highly oxidised carbon compounds appear, while the dark or less illumined face would be electro-positive, since it is here, for the greater part, that the oxygen is liberated.

2. Whether electrodes suitably connected to the opposite faces of a growing leaf, in the presence of sunshine, will show the presence of an electric current arising from an equalisation of the difference of electric potential.

The value of these differences of potential on the opposite faces of growing leaves might, of course, be ascertained by the proper use of an electrometer.

3. Whether a suitable leaf-battery could not be devised, by connecting, in alternate succession, the opposite faces of a series of leaves on a plant stalk.

That is to say, connect the illumined face of one leaf with the non-illumined face of another leaf, and so on in series until any feeble differences of electric potential that there might exist are sufficiently multiplied to sensibly affect the needle of the galvanometer.

4. A comparison of the effects of sunlight and artificial light, such as the electric light, on such electrolytic decompositions.

5. Whether any differences exist in the case of the light produced by an alternating current arc light and that produced by a constant current arc light.

6. Supposing the presence of the differences of electric potential due to the electrolytic decomposition to be established, and the direction of the electric currents so produced known, to ascertain whether an electric current led through the plant in the same direction as the current produced by actinism, would not tend to increase the assimilation and the subsequent growth of the plant, and whether, on the contrary, an electric current sent in the opposite direction through the growing leaf would not tend to check such assimilation or growth.

7. To ascertain experimentally whether the converse of the proposition is true—namely, whether an electric current of approximately the same strength as that produced by actinism, when sent through the leaf in the opposite direction, would not result in the production of luminous phenomena in the leaf.

It would seem to be a matter of considerable interest in the case of these experiments to ascertain definitely whether any marked differences exist between the action of the light produced by a steady current and that produced by an alternating current. In the line of investigations here suggested it would of course seem as if the electric decomposition would be less marked in the case of the light produced by an alternating current than that produced by a steady current. And that therefore in those cases where the electric light of the steady current had proved to be injurious to the growth and assimilation of the plants, that with the alternating current light such injurious effects should be less marked.

* Abstract of paper read before the Franklin Institute.

RESEARCHES ON THE ELECTROMOTIVE FORCES OF POLARISATION.

AN important investigation has recently been concluded by Mons. Le Blanc. Starting with the assumption that electrolytes are present in a dissociated condition in aqueous solutions, he has argued (*vide Zeitschrift für physikalische chemie* viii., p. 299) that the electrical energy which is necessary in order that the ions may be separated from the solution, may be calculated by finding the product of the amounts of electricity peculiar to each ion into the intensities with which these amounts may be attached to the ions. This "intensity of attachment" will vary with the nature of the ion, but will always be the same for the same ion, provided that the influence which the solvent may be supposed to exercise on the dissolved substance remains constant.

If the electromotive force, which is just sufficient to bring about a separation of the ions from a solution of a given salt, be accepted as a measure of the intensity of attachment of the electricity to the ions, constant differences might be looked for in the values of the electromotive force for salts having common ions.

Mons. Le Blanc has put his assumption and chain of reasoning to a practical test, and has conducted a number of experiments in which the above electromotive force for normal solutions of metallic salts has been measured.

The following tables show the results obtained in the case of typical sodium and potassium salts, and demonstrates the fact that in these cases the constant differences predicted by the theory are actually obtained :—

TABLE I.

Salt.		Difference.
Sodium carbonate (Na_2CO_3)	... = 1·71 volts	
		0·44 (*a*)
„ nitrate ($NaNO_3$)	... = 2·15 „	
		0·06 (*b*)
„ sulphate (Na_2SO_4)	... = 2·21 „	
		0·23 (*c*)
„ chloride (Na Cl)	... = 1·98 „	
		0·40 (*d*)
„ bromide (Na Br)	... = 1·58 „	
		0·46 (*e*)
„ iodide (Na I) ..	... = 1·12 „	

TABLE II.

Potassium carbonate (K_2CO_3)	= 1·74	0·43 (z)
„ nitrate (KNO_3)	= 2·17	0·03 (y)
„ sulphate (K_2SO_4)	= 2·20	0·24 (x)
„ chloride (KCl)	= 1·96	0·35 (w)
„ bromide (KBr)	= 1·61	0·47 (v)
„ iodide (KI)	= 1·14	

In Table I. compare the differences, a, b, c, d, e, with those marked z, y, x, w, v, in Table II.

Mons. Le Blanc did not limit his investigation simply to the cases of the salts of sodium and potassium; and the results obtained from other inorganic salts were found to confirm those tabulated above.

Attention was next directed to the organic salts, and a careful set of experiments was arranged and conducted. It was found that all of them gave about the same value, and that this value was practically equal to that for the nitrate and the sulphate. Now, since it is highly improbable that the "intensity of attachment" is the same for the organic as for the inorganic acids, this number must be regarded as the maximum value which the electromotive force is capable of attaining to.

The existence of such a maximum value can, however, only be explained by assuming that in these cases we are dealing not with different processes, but with one and the same process. And Mons. le Blanc is of opinion that this process is the primary electrolysis of the water by the current of electricity. The maximum value is therefore the value for the decomposition of water.

Now, if this be the case, it will be necessary to assume that the water is in a partially dissociated condition, and the electrolysis of any given salt, such as potassium nitrate, would then take place as follows:—

The conduction of the current would take place solely by the ions of the salts, but in the neighbourhood of the electrodes, the potassium (positive) would form potassium hydroxide with the hydroxyl group (negative) of the water, the remaining hydrogen then giving up its charge at the electrode; the NO_3 ion (negative) would combine with the hydrogen (positive) of the water, and the remaining hydroxyl group would give up its charge at the electrode.

Mons. Le Blanc's hypothesis will be found very useful in the present state of our knowledge, in serving to explain a number of facts which have hitherto remained unexplained; as, for instance, the production of pure oxygen at the positive electrode in the electrolysis of acetic and benzoic acids in dilute aqueous solutions.

POLYPHASED ALTERNATE CURRENTS.

(Concluded from page 591.)

II.—DIPHASED CURRENTS.

ALL the apparatus that we have mentioned up to the present work with three wires and three currents, under conditions of perfect symmetry, as we showed at the beginning of this series of articles. We have now to speak of the properties of two-phased alternate currents, the study of which will be greatly facilitated by what we have already found out with regard to triphased currents, and we shall follow the same order in discussing them.

Generators.

The first generator of diphased alternate currents was clearly described in Nikola Tesla's American patent, No. 381,968, dated May 1st, 1888 (application filed October 12th, 1887), as a generator capable of working a synchronic revolving field motor. This generator consisted, essentially, of two bobbins connected at right angles on the same cylindrical armature in the magnetic field produced by suitable inductors. It was a generator with four wires and three currents, but the number of wires can easily be reduced to three by rendering common any two of the wires belonging, respectively, to each circuit. The diphased alternate current generators shown by M. Schuckert at Frankfort in the transport of motive power established between the Palm Garden and the exhibition differs in principle from M. Tesla's in the crossing of the circuits, which altogether prevents the employment of a common return wire, and necessitates the use of four wires proceeding from the generator. Fig. 1 shows the winding of

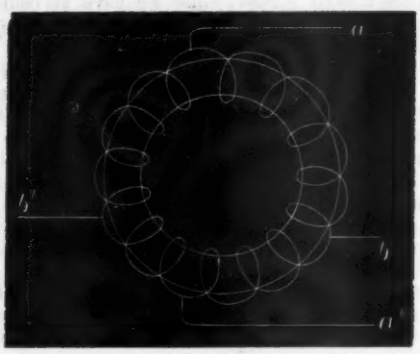

FIG. 1.—DIAGRAM SHOWING THE CONNECTIONS OF A SCHUCKERT ALTERNATE DIPHASED GENERATOR.

this generator, consisting of a simple Gramme ring revolving with a uniform angular speed in the magnetic field produced by inductors excited by a separate current.

On the winding of this ring four collections of current are taken, the two points diametrically opposite a, a' communicate with one circuit, and the other two diametrically opposite points, b b', communicate with the second circuit. As the ring is movable, and the inductors fixed, the permanent connections between the four points of the generator, and the four conductors, are established by means of four collecting rings and four brushes, which are not shown, in order not to complicate the diagram. It would, moreover, be easy to reverse the arrangement by leaving the induced ring fixed, and making the inductors turn. In this case we should get permanent communication between the generator and the outer conductors; two rings and two brushes are sufficient to bring the exciting current to the movable inductors, as in Brown's triphased generator, which has already been described.

On examining this generator more closely, we see that if the circuits traversed by the two alternate currents are clearly separated on leaving the armature, they are common in the armature itself; each quarter of the ring is traversed, at each instant, by the algebraic sum of the two outer currents taken with different signs, according to their connections.

Many other combinations might be employed in order to realise a diphased alternator; but we merely mention those that have been practically realised and applied to some practical use.

Transformers.

We have just seen that the diphased alternate current generators generally contain *four wires*. For reasons of economy on the one hand, and reduction of danger

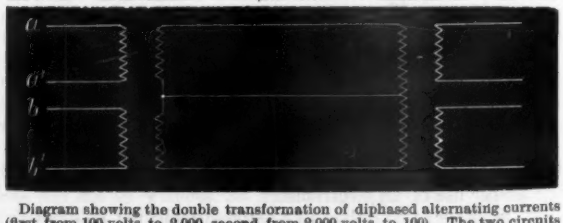

Diagram showing the double transformation of diphased alternating currents (first from 100 volts to 2,000, second from 2,000 volts to 100). The two circuits are perfectly separated on departure and arrival, but have a common return along the line of high tension transmission.

FIG. 2.

on the other, these generators are made of low-tension; it is therefore necessary to transform these currents when they are to be transported to a great distance. The transformer effects this transformation, and, moreover, enables the four wires to be reduced to three along the line of transport.

Fig. 2 shows how this result is easily obtained by a suitable combination of the inductive and induced windings.

In fact, a double transformation is generally resorted to, so as to reduce upon arrival the high potential of the line, and to work at low tension on the utilising apparatus. The Frankfort installation is a typical instance of this double transformation which enables us to have again, upon arrival, the two lagging circuits, perfectly distinct and independent, with four wires instead of three.

The diphased transformer employed by M. Schuckert to transform the 100 volts furnished by the dynamo into 2,000 volts, and again to re-transform upon arrival the 2,000 volts into 100 volts, is shown as a whole in fig. 3, and the details of its construction in fig. 4. This multiple transformer

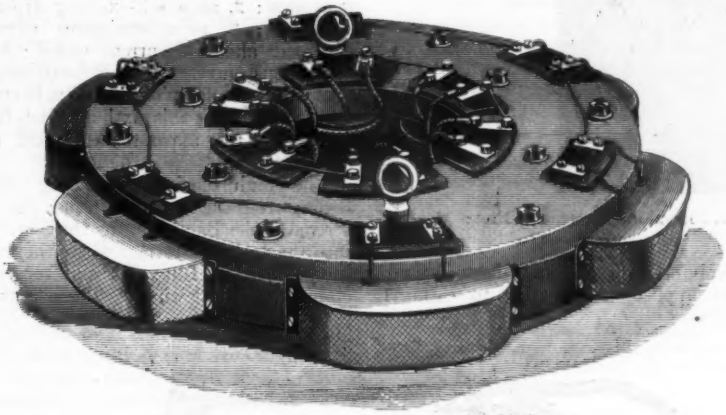

FIG. 3.

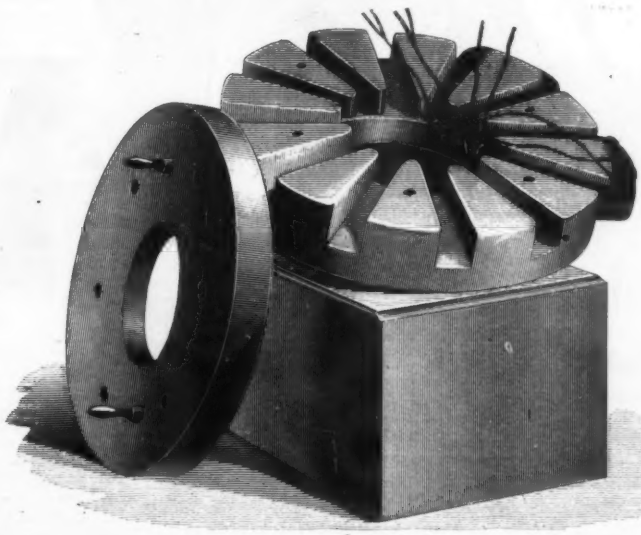

FIG. 4.

belongs to the class of apparatus with a closed magnetic circuit, and consists, in principle, of two annular discs of soft iron. The thicker of these two discs is provided with radiating slots of rectangular section, into which fit the elementary inductive and induced bobbins, which are triangular in form. These bobbins contain windings, the numbers of which are in the same ratio as the coefficient of transformation, and each of them forms a complete group. In the model shown there are twelve radiating slots, into which can be fitted six pairs of bobbins, three pairs for each of the two currents. We can, moreover, modify within considerable limits the ratio of transformation by modifying the coupling of the different bobbins, according to whether they are connected in series or in quantity. The magnetic circuit is closed by adjusting on the first disc furnished with its bobbins the second disc forming a sort of lid for the bobbins. To avoid all danger, the two discs are connected to earth.

This arrangement of the transformers is one of the most simple, and has the advantage, of being applicable, if the bobbins are suitably coupled, to ordinary alternating currents as well as to diphased and triphased alternating currents.

APPLICATIONS.

As with triphased currents, it is possible to apply diphased alternate currents to lighting and to motive power, and to transform them into continuous currents for those applications in which electrical energy can only be utilised under the form of continuous currents. Space does not permit of our entering further into the application of these currents to lighting, the incandescence lamps being connected in derivation on each of the two distinct circuits. We will merely say a few words about motors, and the apparatus employed for transforming these currents into continuous currents.

MOTORS.

The diphased current motors really preceded the triphased current motors. They are synchronic or asynchronic. Although we cannot speak positively on this subject, it seems that the asynchronic motors were invented independently, and about the same time in Italy by Prof. Ferraris, and in America by M. Nikola Tesla. In both cases the researches and experiments date as far back as 1886, but M. Ferraris's motor was not made public until March, 1888, in the *Atti della R. Accademia delle Scienze di Torino*, and the patents granted to M. Tesla, which were applied for in October and November, 1887, were not published until May 1st, 1888.

Fig. 5 shows the principle of Prof. Ferraris's two-current motor; it is reproduced from the original paper. We see here two rectangular circuits, traversed by two currents, with

a lag of a quarter of a period, producing the rotation of a copper cylinder placed in their midst. The theory of the working is the same as that of the three-phased synchronic motor, so that we need not discuss it further. We may mention, however, that Prof. Ferraris, at that time, did not consider that a revolving field motor had any industrial importance, even although he was studying its dimensions in order to increase its power and ameliorate its efficiency (page 10 of the report), whereas M. Tesla took out his patents quite aware of the industrial

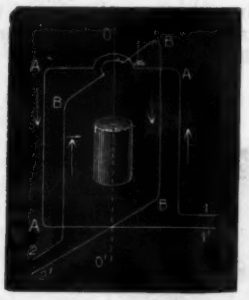

FIG. 5.—PRINCIPLE OF PROF. FERRARIS'S REVOLVING FIELD MOTOR.

importance to which revolving field motors might attain. In fact, they have been applied in America to certain purposes which our American *confrères* have vaguely mentioned; so vaguely, indeed, that it is difficult to say to what extent these applications have met with industrial success. We may say that up to the present there does not exist, *in Europe*, a real industrial asynchronic motor with diphased currents. We do not know how many are in existence in America, and should be glad to receive information on this point.

The same remark might be applied to synchronic motors with diphased alternating currents, for the only case that we can mention is that of the transport of power established at Frankfort, and the motor worked at the Exhibition constituted rather a multiple transformer than a motor properly so called.

DIPHASED MULTIPLE TRANSFORMERS.

All that we have said with regard to triphased current multiple transformers applies equally well to diphased current multiple transformers. In fact, M. Schuckert exhibited at Frankfort a *generator-motor with continuous currents and diphased alternating currents* similar in principle to that which we described in our last article. This apparatus is shown in fig. 6. It consists of a Gramme ring furnished with its collector, and moving in the field produced by inductors arranged along the two surfaces of this flat ring. Four points 90° apart are taken in the winding and connected with four metallic rings insulated from one another, and against which press four rubbers.

This apparatus, constituted in this manner, may perform six distinct functions: 1, it may act as a continuous current generator; 2, as a self-exciting diphased alternate current generator; 3, as a continuous current motor; 4, as a diphased alternate current motor; 5, as a transformer of continuous currents into diphased alternate currents; 6, as a transformer of diphased alternate currents into continuous currents. It was this sixth and last function that was performed by the apparatus exhibited at Frankfort by M. Schuchert.

The high tension alternating currents (2,000 volts) issuing from the first transformer placed in the Palm Garden arrived at the Exhibition by three wires, and were received into a second transformer where they were brought back to the potential of 100 volts, and separated into two distinct circuits with four wires. These four wires communicated

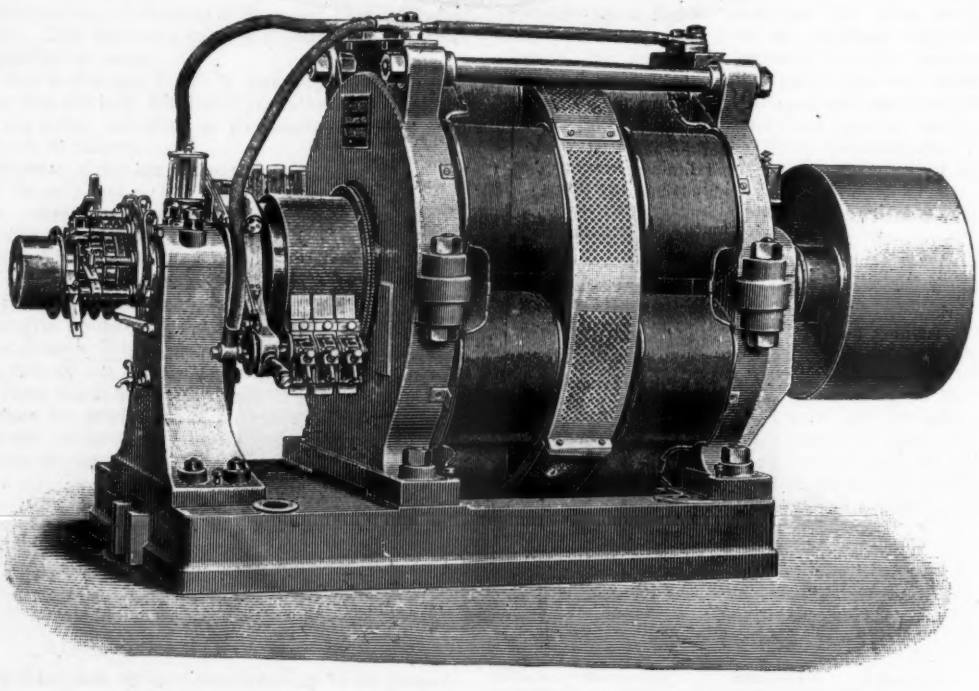

FIG. 6.—GENERATOR MOTOR FOR CONTINUOUS AND ALTERNATING DIPHASED CURRENTS.

with the four rings of the apparatus, which rings are shown at the left of Fig. 6.

The diphased alternate currents passing through the ring tend to produce in it a revolving magnetic field. This field reacts on the inductors, the circuit of which is at this moment open. This produces a motive couple which tends to turn the armature in the same direction as the field and synchronically with it. When synchronism is established all we can do is to close the circuit of excitation on the brushes of the continuous current collector, in order to excite these inductors permanently and ensure this synchronic rotation between the generator motor and the frequency of the diphased currents which feed it.

The continuous current canalisation is branched on these

same brushes, so that from the moment when synchronism is attained and the circuit of excitation closed, we get continuous current supplied by the transformation of diphased alternate currents. This continuous current served at Frankfort to feed continuous current motors of low power working different implements in the gallery constituting the workshop, so that the electrical energy *produced* at low tension in diphased alternate currents on *four* wires was *transported* at high tension in diphased alternate currents on *three* wires, *transformed* into low tension alternating currents on *four* wires, and, lastly, re-transformed into continuous currents on *two* wires. The experiments of the trial committee will show at what cost all these transformations of energy were effected, and, considering the contradictory opinions expressed as to polyphased alternate currents, the sooner the better.

Conclusions.—After this rapid sketch of the properties of polyphased alternate currents, the reader will be convinced that they have many curious and interesting properties, and that as they constitute, as has sometimes been said, a third form of electrical energy, these special properties are worthy of being more fully discussed than in these articles, in which we have given a brief survey of the question. We shall, moreover, soon be enlightened as to the industrial and commercial value of this new branch of electrical engineering by the experiments of the Frankfort Committee and the results of the transmissions of motive power now being established with polyphased currents in different parts of Europe.

The present importance of these currents may be greatly diminished by the discovery of a simple alternating current motor starting with a load, or by that of an apparatus capable of transforming simple alternating currents economically into continuous currents. It is also possible, and even probable, that polyphased currents will constitute merely a *transitory* system of transmitting electrical energy to a distance, as the Jablochkoff candle constituted a transitory system between the arc lamp and the incandescence lamp.

However this may be, polyphased currents will mark a new era in electrical industry; if their life is to be short, it will at least not have passed without honour and interest.

E. H.

CRYSTAL PALACE ELECTRICAL EXHIBITION.

EXHIBITORS AND THEIR EXHIBITS.

THE following is as complete a list of the exhibitors, with brief particulars of their exhibits, as we can obtain at the time of going to press :—

Acme Electrical Works. Teague's patent direct reading electricity meters; Ayrton and Perry's magnifying spring volt and ampéremeters of all types and ranges. Ayrton and Perry's new patent twisted strip volt and ampéremeters. The new "Acme" volt and ampéremeter for switchboard use, having scale extended to 300°. Galvanometers, &c. Morse printing telegraphic instruments and telegraphic accessories such as lightning arresters, paper wheels, &c. Telephones and apparatus for a new burglar alarm system. Switchboards of several types, both main and distributing; also fuse boards of latest design. Improved pattern single and double pole switches, of all sizes and for all purposes; cut-outs and cut-out boxes of the firm's well-known patterns, and general electrical accessories.

Allison and Sons, J. G.

Anders, Elliott and Chetham-Strode: Telephonic and telegraphic appliances, patent domestic telephone, to fit with old-fashioned crank bells, patent automatic switch, patent primary battery, patent electric date and time stamp, patent signature for checking men's time automatically.

Andrews, J. E. H., and Company; Andrews, J. S. F., and Company; Appleton, Burbey and Williamson; Aubert; Automatic Standard Company.

Appleton, Burbey and Williamson. All kinds of electrical supplies, specially notable being the switchboards, distributing boards, lampholders, fuses, &c., and every description of fittings, from plain to elaborate. Also electric bells, indicators, batteries, pushes, wire, &c. A furnished apartment showing the electric light adapted to household purposes, with specially artistic fittings; a fernery is attached with special fittings. A Trusty gas engine driving a dynamo for lighting their exhibits.

Barclay & Son: Electric light fittings, machinery and accessories. A suite of rooms, showing different plans of lighting, and a complete country-house installation on the Scott-Sisling system.

Bawson, G.: Testing instruments, electrical models, small dynamos, electro-motors and magnetic machines.

Becker & Company: Telephones, bells, indicators, switches, pulls, pushes, and electric light wiring and jointing will be practically shown.

Benham & Froud, Limited: The highest class of art metal work as applied to electric light fittings for public buildings, houses and a separate display of church fittings and furniture.

Berg, Emmanuel; Bishop, W. J; Blackman Air Propellor Company; Bolton, R., & Co.

Bourne, J. & Son: Stoneware insulators, battery jars, porous cells, and various descriptions of vitreous stoneware required for electrical purposes.

Bristol Electric Safety Lamp Works: Portable electric safety lamps and accumulators for various purposes.

Britannia Rubber Company: The latest inventions and improvements in manufactured vulcanite and pure India-rubber for insulation purposes, and some of their well-known India-rubber for mechanical use.

British Gas Engine and Engineering Company.

British Stone and Marble Company, Limited: A speciality in electrical insulators, composed of pure silica suitable for dynamos, transformers, main switch plates, terminal plates, accumulators, arc lamps, telephones, telegraph insulators, cut-outs, fuse-boxes, switch plates, lampholders, incandescent lamps, porous cells, ceiling roses, electric bells, and every description of electrical insulators.

Browett, Lindley & Company, Limited; Brown, Wm.

Brush Electrical Engineering Company, Limited: "Brush" and "Victoria" dynamo machines, direct current; "Mordey-Victoria" alternate current machines, "Victoria generators and motors, "Brush" vertical engines, various lamps, switchboards, accessories, and tramcars.

Campbell Gas Engine Company; Cash, N., and Company; Cathcart, Peto and Bradford.

Charlesworth Hall and Company, Limited: Dynamos, high-speed engines and projectors.

Chubb and Son.

Churchill, Chas., and Co., Limited: One of W. F. Taylor's electric motors driving high-class American machine tools of the following description, 1 Flather's lathe 8 inches by 6 feet; 1 Reed's lathe 5 inches by 4 feet; 1 American Watch Tool Company's lathe, 3 inches by 3 feet, with screw cutting inside and outside grinding attachments; 1 American Watch Tool Company's universal milling machine; 1 drilling machine; 1 Dwight slates drilling machine; 1 Brainard's No. 15 tool room universal milling machine; 1 Hendey's 15 inch stroke shaper; also one of W. F. Taylor's motor driving Millers Falls power hack saw. Motive power for driving the dynamo will also be one of the firm's American engines manufactured by the Case Engine Company, of New Britain, Conn., showing a very small engine of very great power. The stand will also be lighted with incandescent lamps supplied by the South of England Electric Company.

Clark and Montague.

Conradty and Company: Mr. Mayer will exhibit on behalf of this firm, arc light carbons from 1 millimetre to 100 millimetres; micro-telephone carbons, and carbons for electro-depositing or smelting purposes.

Consolidated Telephone Company: Gower-Bell Telephones as specially manufactured for the Indian and other foreign governments, for H.M. Postmaster-General at home, and also for the various railway companies, &c., &c.; Blake telephones, &c., &c, as specially manufactured for the National Telephone Company, and various other companies at home and abroad. Telephone accessories, switchboards, annunciators, and all telephonic accessories as supplied to the Indian and other foreign governments.

Cooper, H. and J.; Coxeter and Son.

Crofts, A.: Portable galvanic coil apparatus for surgeons, &c.; also small model dynamo unwound to exhibit iron cores.

Croggon and Company, Limited: A tower on a 6 feet square base running to a height of 30 feet, showing lightning conductor fixed outside of tower. Weather vane on top; belfry with peal of tubular bells showing how large bells can be rung by electricity from a keyboard, and a large single stroke bell. The interior of the tower shows various exhibits. Also a room 12 feet by 10 feet devoted to the display of new pattern patent switch to carry 2,000 ampères with arc interrupter. A large assortment of shades, globes, electroliers, brackets, pendants, new pattern patent adjustable pendant electroliers and single lights, burglar alarms, &c.

Crompton and Company, Limited, Mansion House Buildings, London, E.C., and Chelmsford. a. Apparatus to illustrate the phenomena and laws of electricity and magnetism. Experimental apparatus, parts of dynamos and other machinery showing process of construction. Apparatus for testing the obscure

losses in dynamos, hysteresis, Foucault currents and friction, leakage of magnetic fields.

b. Apparatus for electrical measurements. Crompton patent voltmeters and ammeters for central stations and private installations. Engine room indicators for dealing with heavy currents. Potentiometers. Completely furnished municipal standardising laboratory, for testing and certifying ammeters, voltmeters, Coulomb meters, resistances, and leakage of mains.

c. Electric batteries, primary and secondary. Standard cells (two forms) for taking electrical measurements. Crompton-Howell accumulators for central stations and private house use. One 21 plate battery of 56 cells used for driving lights and machinery, also large experimental cells, including 71 plates as used by Major Cardew for standardising at the Board of Trade. Various sizes for every kind of work, as used, these batteries will be shown in use, giving a very high discharge without injury to their life.

d. Dynamical electricity. One 4-pole Crompton dynamo, 26 by 9, coupled to a Willans II engine giving 420 volts 600 ampères, and drive 8,400 8-candle-power lamps, as used in London central stations and elsewhere. One 15½ by 11½ Crompton dynamo driven by a Crossley engine, and capable of giving an output of 41,000 watts and driving 836 lamps. One Crompton dynamo, small type, to drive 12 lights, another 33, another 100, another 240, another 434, and various other sizes. These dynamos are shown with different windings, shunt, series, and compound. Specimens of armatures of various sizes. Crompton's patent twisted or compressed bars for reducing Foucault currents, and fitted with Crompton's patent sight feed lubricator, &c.

e. Transmission and regulation of the electric current. Crompton's patent system of mains, full sized section on view on machinery stand, copper strip, feeders, house connections, straining up bars, insulators, road boxes, and other apparatus used for mains. Switches of various sizes, including central station switches for heavy currents mounted on slate, standard copper joints, automatic cut-outs for heavy currents, resistance frames, standard switchboard for 50-ampère house installation, central station switchboards complete with switches, measuring instruments, cut-outs, &c., as supplied to Westminster, Kensington Court, Notting Hill, &c. Samples of ornamental mouldings for house wiring by F. A. Fawkes, including picture rails, cornices, &c., to be used as casing for electric wires. Samples of fittings for mining work supplied by Messrs. Mercier, Corlett & Co., including portable lamps, wrought iron brackets, guards, &c.

f. Electric motors. Electro-motors of high efficiency and various sizes as used for colliery and tramway work. Parts of these motors are on view showing solidity of construction; motors for cranes with various windings; motors for pumps, &c.

g. Application of electro-motors. Crompton motors driving electric crane, which will hoist, slew and travel at the same time; electric capstan, heavy lathes, &c.; Crompton motor in action driving Warner's colliery pumps; motor driving challenge fans, supplied by Marchant Bros., for colliery and other work; motors driving wood working and various other machinery.

h. Lighting by electricity. Crompton dynamos combinod with Willans engine capable of giving 252,000 watts, and driving 8,400 8-candle-power lamps. Crompton dynamo driven by "Otto" Crossley's gas engine charging accumulators and driving lights and motive power machines direct. Crompton dynamos in various stages of construction, showing strength of each part with patent windings. This exhibit illustrates the usual type of machine supplying the London and other central stations. Electric lighting of showrooms in gallery, furnished by Messrs. Wallace & Co., consisting of ornamental mouldings and casing by a F. A. Fawkes.

j. Electro-metallurgy and electro-chemistry. Crompton dynamo for despositing, electro-plating, smelting, &c. These machines are made capable of giving heavy currents and of any voltage.

k. Electric welding, stamping, tempering, brazing, &c. Crompton dynamos generating heavy currents for welding, brazing, &c.

l. Electric telegraphs and electric signals. Crompton search lights, projectors, &c., for electric signals, and use in warfare.

q. History and statistics. Pamphlets and descriptive matter giving statistics regarding electrical work and cost of generating electricity.

r. Progress and development in electrical science and construction. Diagrams showing the progress of electrical work including plans of central stations designed in 1882, &c.

Crompton, Howell and Company, Limited; Crossley Brothers, Limited.

Crystal Palace District Electric Supply Company, Limited: A model of the Crystal Palace district showing the boundary of the district, the mains where laid and where proposed to be at once laid, also samples of the cables, wires, &c., the Archer pipes used for street works, a Teague meter; and on the walls, maps, plans, elevation of generating station, engine room, photographs, &c., &c.

Dale & Company; Davey Paxman & Company; Day and Company (Bath).

Davis and Timmins, Limited: A great variety of electrical fittings and small turned work cut from solid bright drawn metal by their patent automatic machinery; standard gauges and tools for the British Association threads; dies and die holders.

Day & Company (London): Megohmeter (provisionally patented), current measuring apparatus, central station companion (patent) fittings. Complete electric lighting set. "Merveilleux" gas engine, oil filter.

Dick, Kerr & Company, Limited: "Griffin" double acting gas engines, various sizes from 2 to 20 horse-power nominal; "Griffin" single acting gas engines, vertical and horizontal types, ½ to 3 horse-power nominal; 20-unit dynamo by Andrews and Preece, Limited; 5-unit dynamo by E. Scott & Mountain, Limited; 3-unit dynamo by E. Scott & Mountain, Limited; smaller dynamos by Roper & Company, Oppermann, Cuttriss, Wallis & Company; Austin's "Infant" dynamo, &c.; plating dynamos and complete plating outfit by Oppermann; "Gilbert" patent arc lamps; large incandescent lamps, 200 to 1,000 C.P. Singer sewing machines driven by electric motors.

Dorman & Smith: Fittings (brackets, pendants, &c.) for all situations, main switchboards, branch switches and cut-outs, porcelain switches, cut-outs, wall sockets, lampholders, &c., decorative porcelain applied to electric lighting accessories.

Douglas & Company; Drake & Gorham; Dreury, W. W.; Easton & Anderson, Limited; Economic Electric Supply Company.

Edison & Swan United Electric Light Company, Limited: Lamps, holders, fittings and instruments manufactured by them; also a screen of lamps filling the whole of the perpendicular area of the nave, which, during one hour in the evening, will be lighted by various changing circuits of coloured lamps, and during the last quarter of an hour will have 200 horse-power thrown into action.

Electric Fittings and Manufacturing Company; Electrical Power Storage Company, Limited; Electric Stores, Limited.

Electropathic & Turkish Baths: Model electropathic bath, domestic electropathic bath apparatus for converting an ordinary bath into an electric bath, model electropathic bath for horses and appliances to be used with the same for curative purposes, electro-medical coils and instruments.

Endolithic Ivory Company, Limited; Epstein Accumulator Company; Evered & Company, Limited.

Faraday & Sons: Electrical fittings for house lighting, artistic electroliers, adjustable pendants (Sir D. Salomons's patents), Eastern, renaissance and Venetian adaptations, lamp shades, hoods and reflectors, gimbal screens, &c.

Applied lighting to a suite of high-class decorated rooms, alternative schemes.

Fielding and Platt.

Floyd, E. M.: Electrical time alarums "New principle."

Fowler-Waring Cables Company, Limited; Fryer, W. J.

General Electric Company: A thoroughly representative collection of articles comprising almost all supplies used in electric lighting, domestic motive-power, telephones, and bells, of which the following is a summary:—Supplies for electric lighting: current meters, ampère and volt meters, arc lamps, electroliers, pendants, brackets and standards, main and branch switches, bracket and pull switches, resistance, and mercury switches, China cut-outs, ceiling roses, wall plugs, and lampholders, cables, flexible wire, and casings. For domestic motive power: motors up to 2 horse-power, driving pumps, lathes, fans, brushes, washing, cleaning, and other domestic machinery. Domestic heating apparatus: electric cigar lighters, stoves, water heaters, curling iron, flat irons, &c. Telephones: pencil, and granular carbon transmitters, double pole bell receivers, switchboards, switches, insulators. Electric bells: a variety of electric bells from 2 inches to 20 inches, indicators, pushes, batteries, wires, &c.

General Engine and Boiler Company; Giles, F., and Company.

Frank Giles and Company: Antique fittings, &c., adapted to electric light.

Gill, A. B., and Company: A 110-light Gill dynamo driven by a 6 H.P. (nominal) Acme gas engine. The current to be steadied by a battery of accumulators and used for lighting and power on stall in nave. Large controlling switchboard with Gill patent switches. A selection of motors, switches, fittings and electrical accessories. They also hope to have on view a new patent electricity meter. An assortment of lamps, shades, &c, &c., will also form part of the exhibit.

Girdlestone, Tatham and Company. This firm have been obliged to decline the space allotted to them owing to pressure of business, but they are exhibiting at Messrs. Charlesworth, Hall and Company's stand two Andersen arc lamps (of which they are sole manufacturers) for lighting their stall; the lamps will be run from their own engine and dynamo.

Girtanner and Huffeld.

Glover, W. T., and Company: Examples of their varied manufactures from the raw material to the finished article, in the shape of wires and cables suitable for telegraphy, telephony, electric light, aerial, and underground work. A notable novelty in their exhibit is their new flexible armoured cable, combining a maximum of protection with a minimum of weight.

Gordon, J. E. H., and Company; Graham and Biddle.

Green, W., and Son: Dynamo brushes, wire gauze, Dowsing's patent waste-preventing "clips" for dynamo brushes.

Groombridge and South.

Groth, L. A.: I. Diagram of complete tannage—14 days' of green hides, each of 77 lbs. weight, showing their daily absorption of tannin from the liquor. 2. Diagram of comparative tannages, viz., with and without the aid of electricity; the upper curves show gradual loss of tannin from the liquor, and the lower curves show the corresponding quantity absorbed by the hides. 3. Samples of leather belting tanned by Groth's system in three weeks, and tested by Prof. W. C. Unwin, F.R.S., showing an unusual uniform tannage and great tenacity. 4. Leather belting made up from Groth's leather. 5. Sole-butts and strap-butts tanned in four weeks. 6. Boots made from Groth's leather. 7. Pair of boots, worn for five months, one sole made from Groth's leather, and the other one from leather tanned by Messrs. Mellor and Sons, Manchester.

Groves, W.: 6-metre Wheatstone bridge; Improved Wheatstone rheostat; 100,000 resistance box; student's box of coils and bridge; student's one ohm in tenths resistance box; student's reflecting galvanometer; micrometer wire gauge ½-mm. pitch; gold leaf electroscope; galvanometer, variable sensibility; 100-cell water battery; deflection magnetometer; comparison magnetometer; Prof. Hughes's microphone; Prof. Hughes's sonometer; shunt box; ballistic galvanometer.

Gülcher (New) Electric Light and Power Company, Ltd.: Dynamos, transformers, lamps, arc and incandescent, switchboards, motors, fittings, &c.

Habgood, Wm.: Small arc lamps of low candle-power for interior lighting; variable resistance frames and switches for same.

Harburg India Rubber Comb Company; Harris, Josiah; Hartnell, Wilson.

Henley's Telegraph Works Company, Limited: Cables and wires for electric light; telegraphs, telephones, &c.; flexible cords, patent metallic braiding, underground cables, specimens of ocean bed obtained from deep-sea soundings, submarine cables, raw gutta-percha, raw India-rubber, &c., electrolytic copper (100 per cent. pure) as used in the manufacture of all their copper wires, "Block" dry cells, &c., &c.

Hindley, E. S.: A 10 H.P. nominal horizontal engine on cast iron foundation; a 5 H.P. nominal horizontal engine on cast iron foundation (driving Phœnix dynamo); one 7 inch by 7 inch new type high speed vertical engine (driving Phœnix dynamo); one 6 inch by 6 inch new type high speed vertical engine; one 4 H.P. nominal vertical engine, "The Alcazar;" one 1 H.P. nominal vertical engine, new design; one band saw machine driven by electric motor; Hindley's worm and wheel hoist driven by electric motor: Hindley's new equilibrium governor controls the speed perfectly under the greatest and most sudden variations of the load, and is adjustable while running.

Hodges & Todd: Ammeters, voltmeters, switchboards, and double-pole switches, telephones, pushes, &c., battery cell testers.

Homacaustic Speaking Tube Company: Electric communication combined with the Homacaustic speaking tube instruments for use on board ship and noisy places, as well as other instruments for domestic purposes.

Hornsby, R., and Sons, Limited, are not exhibitors but supply the following plant: 5 large horizontal compound steam engines of 150 horse-power each, placed side by side, so as to drive 5 dynamos which are arranged directly behind them. These engines are fitted with Hornsby's latest patent spring governor automatic expansion gear so as to ensure the greatest steadiness of running and economical consumption of steam. They work with 140 lbs. steam pressure and run at 95 revolutions per minute and have 14-feet flywheels grooved for rope driving gear. There are 5 large boilers also supplied by Messrs. R. H. and Sons, and which are of the locomotive multitubular type having very large grate and heating surfaces. They are arranged side by side. Four large feed water heaters are also fitted and two duplex feed pumps for feeding the boilers. The whole of the steam and feed piping is arranged in duplicate, which is now the plan always followed in the best installations. The whole of this plant was contracted to be made and delivered in 3 months and the contract has been faithfully carried out.

Hulett and Company, D.; Humphrey, J. C.

Ingersoll-Sergeant Drill Company: 1 "Crescent" magneto electric blasting machine for mines, cannon, &c., 20 charge capacity, ready for use; 1 "Crescent" magneto electric blasting machine without cover, showing mechanism; 1 standard electric fuse and blast tester; 1 leading wire reel and holder; 1 connecting wire reel holder; specimens of connecting wire, leading wire, and insulating tape.

International Electric Company: Telephonic and telegraphic installations for private houses, factories, &c., fire alarms, signalling apparatus, water level indicators, microphones, telephones, "line selector," installation, models illustrating development of M and G microphone, apparatus for enabling guard or driver of a train to establish telephonic communication with nearest station in case of accident, &c., telephonic exchange apparatus, automatic telephone call-box, and Frager electricity meter (working).

Jenner, T.: Patent wire gripper, for use in straining telegraph and fencing wires, &c.; railway carriage and watchman's lamp, patent applied for; patent carbon-holder for arc lamps and telegraph constructor's ladder (patent applied for), especially adapted as a life-saving ladder, affording a ready means of speedily effecting a communication between the street and the upper floors of a burning house.

Joel, H. F. & Co.: "Joel" patent slow-speed dynamo, latest and most improved type: The special advantages claimed for the "Joel" dynamo, in addition to that of slow-speed, are: 1, high efficiency; 2, simplicity of construction, enabling repairs to be executed without skilled labour; 3, arrangement for cleaning and adjusting brush-nolders; "Joel-Pilsen" arc lamps, improved type, gold medal awarded, Crystal Palace Electric Light Exhibition, 1882, over 20,000 in use; "Joel" patent motors for driving ventilating fans, sewing machines, electric launches, &c.; "Joel" patent ammeters; "Joel" patent switches; switchboards fitted with voltmeter, ammeter, main switches and cut-outs, mounted on enamelled slate, &c.

Johnson & Phillips: Electrical department—Dynamos, alternating and continuous current; transformers, Brockie-Pell arc lamps, switchboards, secondary batteries, motors, cables, and leads, lamp-posts, and lamp carriers. Telegraph department—Small picking up gear; hauling gear; buoys, buoy ropes and fittings; grapnels (various) and grappling rope; mushrooms, centipedes (various); insulators (for land lines and electric light leads); telegraph poles; land lines instruments.

Jooss, Albert; Kennedy, Rankin.

Kelway, C. E.: Kelway's A B C marine and general electrical signals for night work; Kelway's A B C marine and general electrical signals for day work; Kelway's electric log and naval range-finder; Kelway's non-penetrating projectile and electric shell fuse; Kelway's combined sounder and fire alarm; Kelway's storage battery; Kelway's range-finding chronograph watch; Mills' tubulous boiler; Gosling's boiler fuel economiser and smoke reducer.

Lacombe & Co.: Arc light carbons; carbon discs for disc arc lamps; fluted carbons as used for lighthouses and search lights (up to 70 mm. diameter); Lacombe's patent central zinc manganese cell; carbon brushes for dynamos and motors; carbon resistances; microphone carbons; carbon headed and other plates for batteries.

Laing, Wharton & Down: A most complete variety of plant, accessories, and fittings for all classes of electric light and power installations, including one of their "Special" dynamos on sliding rails, compound wound, giving an output of 500 ampères and 100 volts, at a speed of 525 revolutions per minute, and capable of sustaining 850 incandescent lamps of 16-candle power each, or acting as a generator for 70 horse-power electro motor; an "Otto" high-speed engine by Messrs. Crossley Bros., Ltd., driving an L. W. & D. "Special" dynamo, compound wound, for an output of 90 ampères and 100 volts, to sustain 150 incandescent lamps of 16-candle power each, or give 10 horse-power as a generator for electromotors. Two specimens of their direct coupled ship lighting plants, the larger consisting of double cylinder, vertical, high-speed engine by Messrs. Robey & Co., of Lincoln, driving a four-pole "Special" dynamo capable of sustaining 400 incandescent electric lamps of 16-candle power each, at a speed of 350 revolutions per minute, with a steam pressure of 120 lbs. per square inch. The smaller, a similar plant with single cylinder engine, and capable of sustaining 60 lamps of 16-candle power each at a speed of 325 revolutions per minute and a steam pressure of 50 lbs. per square inch; Messrs. Laing, Wharton & Down direct special attention to their "Special" dynamos, which, owing to the complete absence of external magnetism, are incapable of affecting watches brought into their vicinity, and are more particularly useful on shipboard on account of their not deflecting the compass needle. They will likewise show a "Bruce" patent signalling balloon equipment; an electromotive force regulator for use where the driving power is irregular, and which will reduce the fluctuation of potential to within 1 per cent. of the normal; their quick break main and branch switches; main switchboards for use with installations running direct and off accumulators; the latter board being fitted with their two-way ammeter switch, to enable the charge and discharge current being read on the same instrument. A complete assortment of safety fuses; wall connectors and other accessories for private house, factory, and marine installations; artistic and plain brackets; electroliers, and other fittings. A dining table fitted with candelabra and single candlesticks adapted for electric light with their "perfection" artificial candles, will be shown in conjunction with Messrs. Phillips, 175, 177 and 179, Oxford Street, W.

Laing, Wharton & Down Construction Syndicate, Limited: A large and varied collection of Thomson-Houston machinery and apparatus, representing the latest stage of progress as applied to lighting, railway work, power transmission, and the various applications of the latter in the way of mining and other machinery. The various exhibits may be briefly enumerated as follows:—A 14-H.P. "Otto" gas engine by Messrs. Crossley Bros., Limited, driving by belting from a flywheel on either side; a 30-light Thomson-Houston arc dynamo of the well-known type, and Prof. Elihu Thomson's high rate of alternation dynamo of very recent construction; a 30-H.P. Willans engine, combined with a marine dynamo wound for 80 volts, and to give an output of 16,000 watts at 400 revolutions; a 13-inch naval projector; a diving lamp of 50 candle-power for 80 volts with 50 feet of flexible cable, forming an interesting addition to the marine plant; a 15-H.P. continuous current generator, fitted with a special mechanism, consisting of a third or rotating brush operating; a Van de Poele electric rock drill, which has a capacity to bore a hole 1½ inches to 2 inches in diameter at the rate of something over 2 inches in a minute, and this in very hard granite. This drill can bore, if necessary, to a depth of 10 or 12 feet, as the power of the coils is sufficient to raise a very heavy drill rod; a triplex electric pump, with 8 inches by 8 inches cylinder, which is equipped with a 10 H.P. waterproof motor geared directly to it by fibre pinions and iron gears; a 10-H.P. electric motor geared directly to a hoisting drum, making a compact and semi-portable arrangement of considerable value and utility on docks for handling heavy merchandise, or in mines, either for use at the

head of the shaft, or underground to operate systems of rope haulage. This motor is made with special insulation, adapting it to withstand moisture. In addition to the foregoing exhibits, will be found two motors of 10 H.P. and 20 H.P. each, designed to run at a constant speed, regardless of the amount of work demanded of them. They resemble the generating dynamos in every respect, except that they are without series winding. The Laing, Wharton & Down Construction Syndicate, Limited, are also exhibiting a new type of alternating current dynamo, known as the "X" type, which may be considered a model of the large machines to be employed by the City of London Electric Lighting Company, Limited, in the lighting of the east district of the City of London. The Thomson-recording wattmeters exhibited by the syndicate are of the type which took the first prize in the recent electricity meter competition held in Paris. The *primary* meter exhibited is for use with alternating current installations in the central station, and registers the total output of a dynamo, or the consumption of a single circuit during any specific period. This company also show a central station switchboard, mounted on slate, for use on electric railway and power circuits. Arc and incandescent lamps, which are in use in so many different towns employing the Thomson-Houston system, and lightning arresters, constructed on the well-known principle of a repulsion existing between an arc and a magnet, are also shown. Especial mention should be made of the Thomson experimental devices in connection with alternating current, which created so great a sensation at the Paris Exhibition in 1889, and which procured the professor the coveted decoration of Chevalier of the Legion of Honour.

Lewis, J.: The "Lewis Link," an improved coupling for lightning conductors, invented by J. Lewis; lightning conductor apparatus and appliances; model showing method of erecting a lightning conductor on chimney shaft.

Livi, S. & H.

London Metallurgical Company, Limited: A full-sized model of yacht's cabin fitted up with electric lights, also dynamos, motors, and other electrical apparatus, all of which will be coated by the system of Arcas plating to prevent corrosion and rusting.

Lundberg, A. P.: Quick-break switches in all sizes, on slate and porcelain, ceiling rosettes, cut-outs, wall and floor sockets, combination switch wall sockets, two way and suspension switches, and other specialities of my own design. Principal feature, the "Unique" switch, being an entirely new quick make-and-break switch, with several modifications of same.

Mackie, W.: A 500-16 C.P. light dynamo, running at a speed of 350 revolutions per minute and at 100 volts, coupled direct to engine.

Maquay Electric Light Syndicate, Limited: Primary batteries to light from 40 lamps down to one lamp; also hand lamps for stables or packing rooms or warehouses; surgical lamps, dentists' lamps, miners' lamps, divers' lamps; also small batteries for bedrooms, for reading in bed; and other novelties for driving large and small motors.

Marryat, Lillywhite & Co.: Electric lighting appliances; burglar and other alarms; wood casings, &c.

McKinnell & Co.: A vertical high speed gas engine, at work, driving a "Mackie" dynamo; a ¼-H.P vertical gas engine, and specimens of dynamo castings of high magnetic permeability.

Mining & General Electric Supply Company; Morgan-Grenville, Capt. L.; Mosses & Mitchell; Nalder Bros.; National Telephone Company, Limited; Negretti and Zambra.

Mining & General Electric Lamp Company, Limited: Lithanode miner's lamps, lithanode electric lighting cells, and cells suitable for traction and similar purposes, also a variety of electric hand-lamps for domestic use, for use in gas works, petroleum ships and gunpowder mills, and for divers' uses, reading and travelling lamps, a complete battery, motor and propeller, &c., for actuating an electric canoe; ampèremeters, voltmeters, automatic cut-outs, hydrometers, and other secondary battery accessories.

Nalder Bros. & Co.: Electrical testing and measuring instruments.

Newton, F. M.: Taunton steam dynamo; launch motor; Newton-Hawkins automatic switches; N. & H. swinging switchboards; transformers; arc lamps.

Ochs, Karl; Ostler, F. & Co.

Parsons, C. A., & Co.: One steam turbine dynamo, 24 units, of latest type, the turbines being steam jacketted, an intermittent admission expansion governor, electrically controlled, regulates the steam supply; one search light projector of modified Admiralty design; 12 mirrors of 36 inches, 24 inches, 20 inches, and 16 inches diameter, all of which are of truly parabolic form and accurate figure, for giving the most powerful parallel beams of light with a minimum loss of surface reflection and absorption of the glass.

Paterson & Cooper; Perkins, F. C.; Pitkin, J.; Pritchett and Co., G.E.B.; Pyke and Harris.

Rashleigh Phipps & Dawson: Electrical novelties and examples of their metal work, and one of the peculiarities of their stand will be that it will contain nothing that has not been both manufactured and designed by them. The firm is also engaged upon lighting the stage of the pantomime, and in fitting up a drawing room, dining room, hall, and conservatory in the gallery, to illustrate the best means of lighting same.

Rawlins & Walker; Reidel, F. J.

Renshaw & Co.: A Renshaw patent 50-H.P. triple expansion condensing engine, with Renshaw's patent surface condenser and air and circulating pumps; the engine is coupled direct to a Mackie dynamo.

Richard Frères: Direct reading and self-recording instruments of the following kinds: Universal controlling chronograph; cinemometers or tachometers; cinemographs or tachographs; dynamometers; electricity meters; planimeter or integrator; thermographs; pressure gauges; vacuum indicators; ventilators; voltmeters, ammeters, for direct and alternating currents.

Round, John; Sandwell, W. D.; Schanschieff; Schroeder, H. & R.

Scientific Alliance: Primary battery; small electro-motors; electrical novelties; electric lights; small power from battery.

Scott, R. A.: Exhibits will consist of engines and dynamos, motors, switchboards, electric light fittings, search light projectors, Scott's patent search light mirrors, diverting lenses, &c.

Sharp & Kent

Shippey Brothers, Limited: (1) Various sizes and types of the Curtis, Crocker-Wheeler and Eddy American electric motors. (2) Sewing, washing, boot-cleaning and other domestic electric appliances for working on arc or incandescent circuits. (3) Samples of the Woodward, Detroit and standard storage batteries. (4) Specimens of the Woodward 2,000 ampère-hour new multipolar battery for central stations. (5) Story system of American coal cutter and electric rock drills. (6) New designs in Shippey's coloured and fancy glow lamps for decorative incandescent lighting; also new type 100 and 110 volt 56 B lamps for ships, cabin lighting; cheap glow lamps for export and Colonial uses; specimens of the Edison and Swan damaged lamps repaired under Shippey's patent process. (7) Samples of the new T. and T. Boston telephones, also samples of the Law telephone battery and standard dry cells. (8) Samples of the new 4 ampère, 50 volt, 500 Gun arc lamps for shop, theatre and factory lighting, and samples of the new Waterhouse 2,000 C.P. lamps for street lighting. (9) Various types of Shippey's standard volt and ammeters; new cell tester and testing instruments. (10) Various types and designs in new patent lampholders, D.P. switches, fittings, shades and American glassware.

Shirley & Co.: Electric light fittings.

Siemens Bros.: Shunt and compound wound dynamos, in connection with Willans's G.G. and open engines and Tangye compound vertical engine; down and up transformers and high tension (50,000 volt) transformer; electrically controlled and hand regulated holophotes; iron telegraph posts, carbon contact switches, electric light carbons, electric railway signals, model of cable ss. *Faraday*, cable samples (submarine and torpedo), torpedo apparatus, submarine, &c., testing apparatus; Wheatstone, Morse, Mirror and Recorder signalling apparatus; dynamo and magneto exploders, electrical and water pyrometers, various batteries, model theatre lighted by electricity, apparatus for illustrating the curves formed by telephonic vibrations, apparatus for comparing the magnetic permeability of iron, apparatus for showing method of working long multiple cored cables so as to eliminate induction disturbance between the cores, engine room telegraphs, electric fire-engine, winch and drill, motors and fans, reflectors, pendants, brackets, test cart for street work, jointing tent, straight and T jointers, double current translation apparatus, Bagnold's bell-pull, various insulated wires, ebonite, raw and washed rubber, tools, &c.

Smith, Newton L.: A new principle in hernial trusses, entitled the "Imperial Silver Truss." It is a truss made of one piece of silver wire, and is applied to the person of the wearer in a manner entirely new.

South of England Electric Manufacturing Co. Electric welding machinery, electric augur twisting machinery, electro-motors, dynamos, transformers, engines, and a model of the P.P. system of electrical distribution.

South of England Electric Light Company; Spencer, John.

Stegmann, Geo.: Telephone and electric bell appliances (improvements, &c.)

Suter & Co.: Picture lighting appliances (reflectors, standards, &c.); a picture gallery lighted by Frank Suter & Co.'s system of picture lighting.

Swinburne & Co.: Hedgehog transformer (patent), capacity from 400 to 450 lights; condenser (patent) in cast iron boxes for central station use. These are made for any volts from 200 upwards. Cable testing transformer (patent) for high volts. This will be shown working at certain hours. Another smaller ditto for 20,000 volts continuous current transformer (patent). Alternating current wattmeter for central station use. It has a large range and small loss of power, about 1 per cent. of the load, and is extremely delicate. Station electrostatic voltmeter, 2,000 volts. This is specially designed for reading the full scale for 20 per cent. The Fox-Bourne galvanometer; special portable design. Alternating current ammeter for central station use. Continuous current voltmeter for central station

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CRYSTAL PALACE, September, 1891. HENSHAW RUSSELL, Manager. 4848

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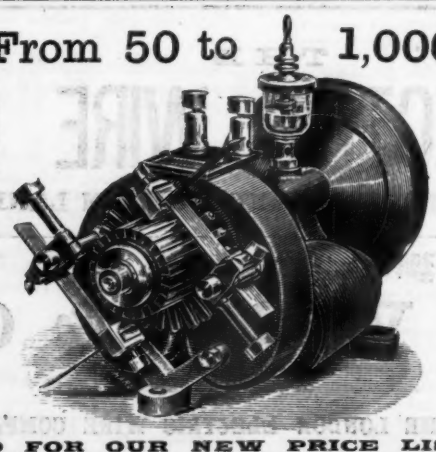

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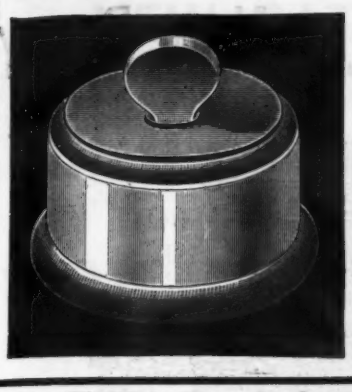

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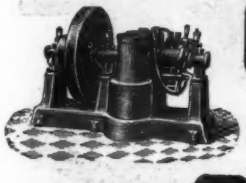

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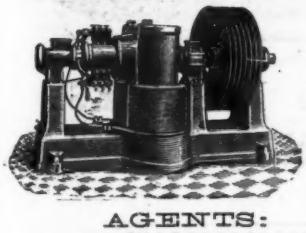

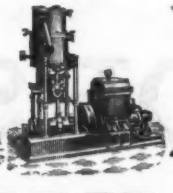

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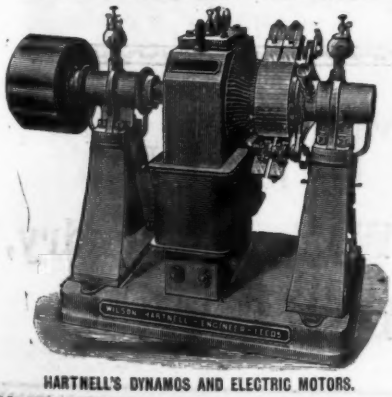

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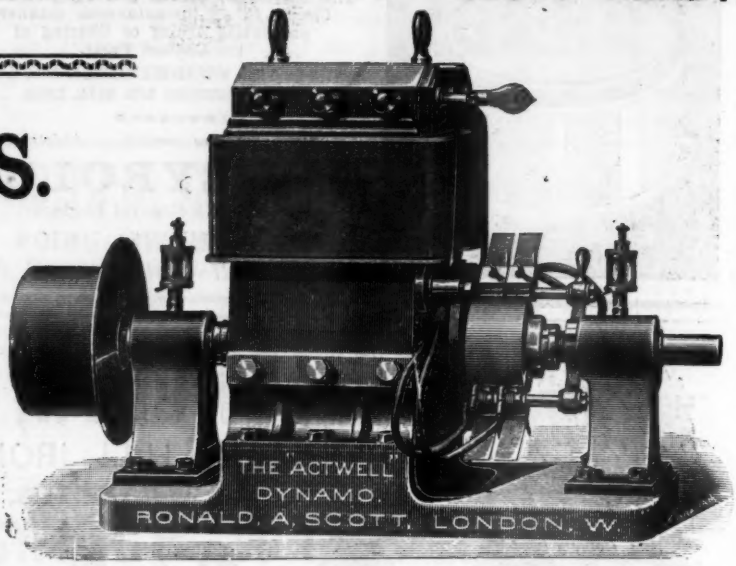

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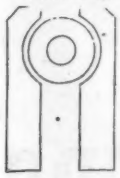

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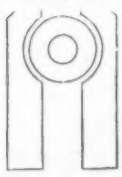

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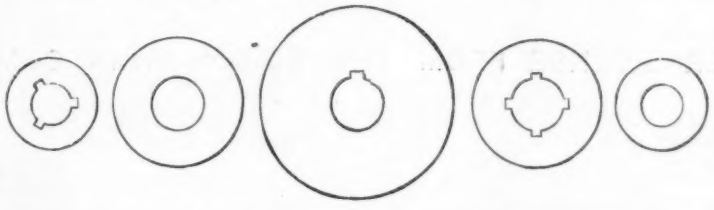

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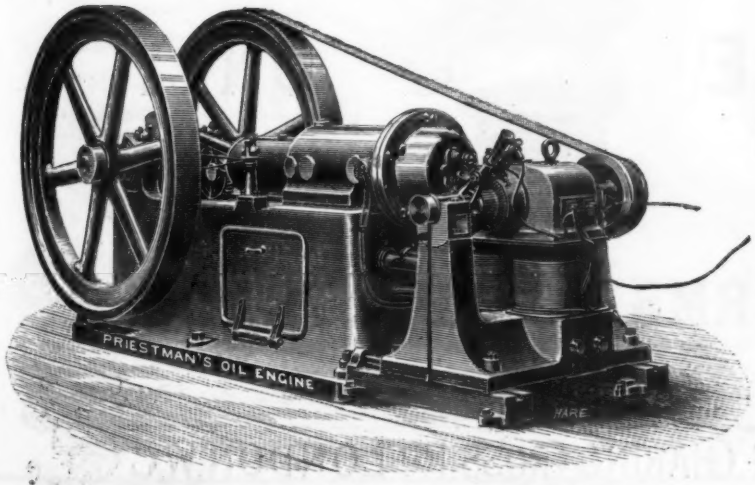

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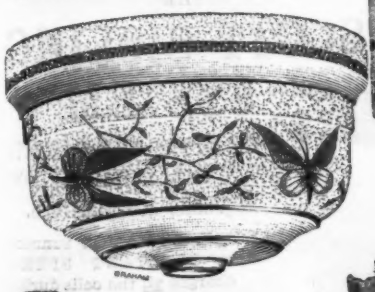

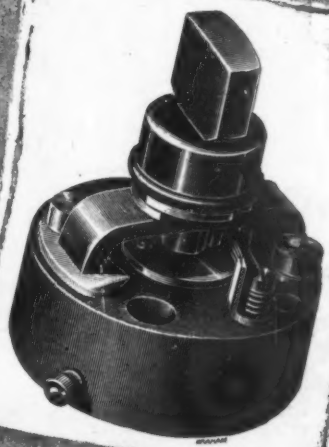

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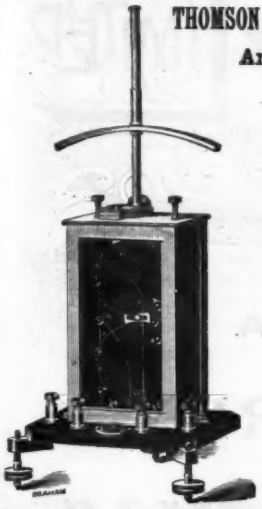

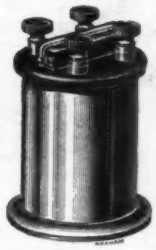

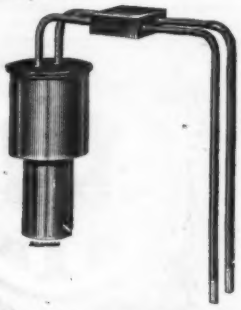

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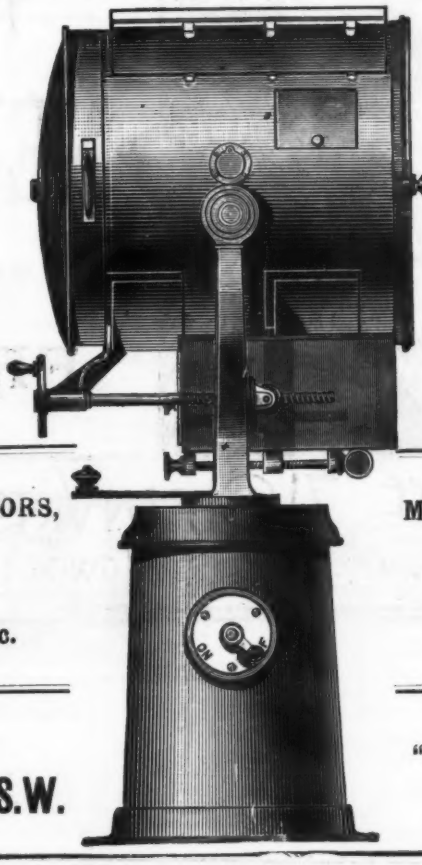

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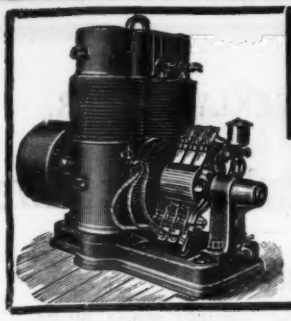

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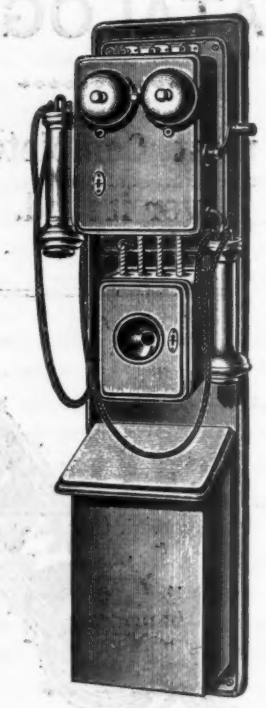

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Its success as "THE ELECTRICAL TRADES' GUIDE" is unprecedented.

8-page Circular on Application to the Sole Proprietors,

H. ALABASTER, GATEHOUSE & CO., 22, PATERNOSTER ROW, LONDON.

THE NATIONAL TELEGRAPH WORKS COMPANY, LIMITED.

No. 10.] BIRMINGHAM, DECEMBER 25TH, 1891. [LEWIS'S SYSTEM.

MANUFACTURERS OF

Poles, Pole Chairs, Iron Standards, Stay Rods, Struts, Swivels, Spurs, Wall Plates, Channel Iron Arms, Oak Arms, Pole Clips, Pole Brackets, Angle Brackets, Chimney Brackets, Saddles, Roofs, Finials, Caps, Iron Hoods, Hoop Guards, Wire Guards, Lightning Points, Pole Steps, Angle Plates, Staples, Nails, Washers, Insulators, Shackles, Insulator Bolts, Cables, Wires, Leads, Printers, Sounders, Keys, Single Needles, Bright's Bells, "A B C" Instruments, Duplex and Quadruplex Apparatus, Telephone Magnetos, Transmitters, Receivers, Generators, Electric Bells, Indicators, Pushes, Burglar Alarms, Mining Gongs, Fire Station Switchboards, Street Pillars and Wall Boxes, Night Watch Tell-Tales and Thermostats. Batteries, Screws, Terminals, Cabinet Case Work, Testing Apparatus, Construction Tools, and every description of Apparatus connected with Telegraph, Telephone and Electric Light Engineering, &c.

Managing Director:

Mr. J. SLATER LEWIS.

OUR NEW CATALOGUE

Is in course of preparation, and we hope to be able to fix a definite date for issuing same shortly. Meantime we have prepared price sheets, which we shall be happy to forward on application.

Postal Address:
THE NATIONAL TELEGRAPH WORKS Co., LTD.,
Aston, Birmingham.

Telegraph Address: "THUNDER, BIRMINGHAM."
Telephone, No. 2,542.

THE
National Telegraph Works
COMPANY, LIMITED.

FRIDAY, DECEMBER 25TH, 1891.

INTRODUCTION.

WE have no apology to offer for adopting a style of advertising which was introduced by our Managing Director some seven or eight months ago, when connected with another establishment. We shall, from time to time, describe, to the best of our ability, the various manufactures we have taken up, and for the present, at all events, we shall not attempt to illustrate any of our goods. Our quality of work is well known, and we shall endeavour to maintain the reputation which our Managing Director, and the staff of 25 hands who have followed him, have earned in the past. The whole of our plant is positively and absolutely new, and much of it of recent design and possessing improved features of great value. We are in a position to turn out interchangeable work with the greatest accuracy, and we warrant our goods to be in every respect first-class, and equal to those offered by any house in the trade; while, as to price, we feel assured that our terms will compare favourably. We never have and never will attempt to compete with the cheap foreign articles sold by some of our competitors. We shall at all times endeavour to give the highest satisfaction to our friends, and we trust that they will favour us with a small share of their kind support.

MANUFACTURING.

In commencing operations we have borne in mind the now well-known fact that it is the quantity and regularity with which any particular goods are dealt with which enables the manufacturer to trade with advantage to his customers and profit to himself. We have, therefore, laid ourselves out for certain well-known "lines," and although we shall, of course, take in special work, we shall not depart from the original plan. This will enable us to offer certain classes of goods at prices which will strike buyers as being extremely favourable, and which, we anticipate, will bring us a fair return for our labour. We hope next week to deal with a few of these manufactures.

LECLANCHÈ BATTERIES.

We beg to notify the fact that we are continuing the system of supplying Leclanchè Batteries in cases of dozens, three dozens, half gross and one gross lots, as introduced by our Mr. SLATER LEWIS some time ago. Our present price is 10s. 6d. a dozen free on rails Birmingham, net, packing cases free. We guarantee these Batteries to be throughout of the best materials. We have had ten years' experience in the manufacture of these goods, and with new appliances and reorganised systems are in a position to offer a better article than any other house in the trade.

MANUFACTURERS and CONTRACTORS to the Admiralty, War Office, H.M. Post Office, and the Principal Electric Light Companies and Contracting Firms.

NOW READY,

AND SENT ON RECEIPT OF TRADE CARD,

OUR NEW

PRICE LIST OF

Electric Light Cables.

HELSBY,
December, 1891.

HIGHEST REFERENCES as to QUALITY and DURABILITY.

LONDON TELEPHONE No. 1935.
LONDON TELEGRAMS: "CONCENTRIC, LONDON."

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1,000 LAMPS FOR 5 HOURS
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GROSS PRICE (COMPLETE WITH ACCESSORIES AND STANDS) **£2,000**

MAINTENANCE - - (PER ANNUM.) **£143**

Being at the rate of 7½ Per Cent. Per Annum on the Cost of Cells only.

NOTICE IS HEREBY GIVEN that every MANUFACTURER and individual USER of any SECONDARY BATTERY of the TYPE, CONSTRUCTION or FORM covered by the above COMPANY'S PATENTS, without a licence, renders himself responsible for such UNLAWFUL MANUFACTURE, and all the CONSEQUENCES thereof.

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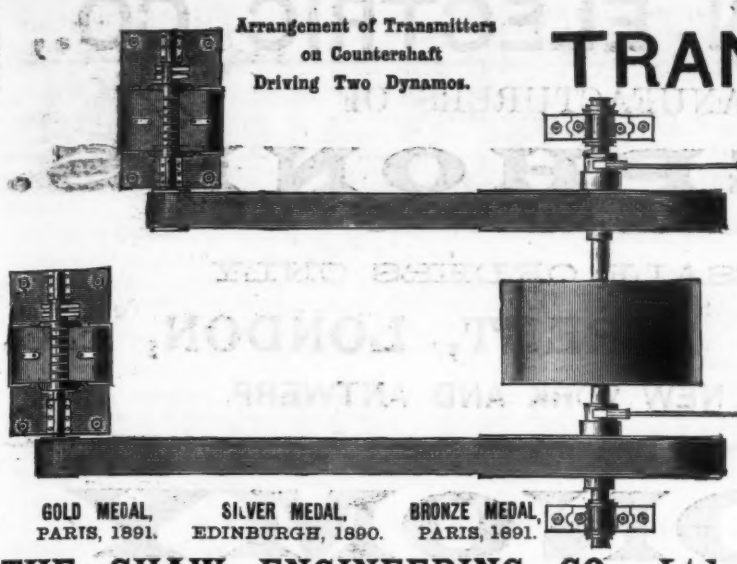

Arrangement of Transmitters on Countershaft Driving Two Dynamos.

GOLD MEDAL, PARIS, 1891. SILVER MEDAL, EDINBURGH, 1890. BRONZE MEDAL, PARIS, 1891.

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ASHTON GATE, BRISTOL.

THE
TRANSMITTER,
Specially suitable for
ELECTRIC LIGHT INSTALLATIONS,
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COIL GRIP
Clutch or Coupling,
AND IS SUPERIOR TO ANY FORM OF
FRICTION CLUTCH.

THE LEVIATHAN BELT.
The STRONGEST and BEST for ELECTRIC LIGHTING. 10-inch Belts are running night and day at
ELMORE'S COPPER DEPOSITING WORKS, LEEDS,
On large dynamos at 6,800 miles a week.
ALSO LARGELY USED AND RECOMMENDED BY ELECTRICAL ENGINEERS.
Apply for Samples, &c., to HEBBLETHWAITE BROS., Patentees and Sole Makers, HUDDERSFIELD. 4080

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VULCANITE & EBONITE.
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SHEET, RODS, OR TUBES. SPECIAL REQUIREMENTS MADE TO ORDER.

VULCANITE CELLS AND PATENTED SEPARATORS FOR SECONDARY BATTERIES.

Pure Para Telegraph Strip, Insulating Tape, &c. Patented Non-Stretching Pure Rubber Insulating Tape. Rubber Goods of all kinds for Electrical Purposes.

PATENT COTTON "SIMPLEX" BELTING
For DYNAMO, MAIN, and OTHER DRIVING.

Valves, Sheet Rubber, Hose Pipes, Fire Hose, Chemical Appliances, Waterproof Garments, and all kinds of India-Rubber Goods in Stock, and to Order.

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57, Miller Street, GLASGOW.
20, Rue des Marais, PARIS.
14, Place Sainte Gudule, BRUSSELS.
29, Ki Reichenstrasse, HAMBURG.

4130

WESTERN ELECTRIC CO.,

MANUFACTURERS OF

TELEPHONES.

WHOLESALE ORDERS ONLY

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CHICAGO, NEW YORK AND ANTWERP.

ECONOMY

in mining is most essential, and electrical pumping and haulage will effect a saving in working cost of 20 per cent. on compressed air or steam, and upwards of 50 in capital outlay. Our machinery at work in all parts of the country will prove this, and we shall be pleased to estimate for Electrical Transmission Plant to any requirements.

Referring to the Abercanaid Haulage Plant, just installed by our Agent, Mr. J. C. Howell, of Llanelly, the "Merthyr Express" says: "Thus started the First Electrical Haulage Apparatus in South Wales, the success of which, beyond all doubt, will lead to its adoption in every important Colliery throughout the two Countries."

Electric Lighting, Electric Pumping, and Electric Haulage, the three things necessary in mines, can be carried out from the same generating station, and power distributed over long distances when required.

Mr. J. C. Howell, of Llanelly, and Messrs. Mercier, Corlett & Co., Wigan, our Local Agents will supply Estimates, and give every Information respecting Electrical Work in their Districts.

FURTHER INFORMATION SUPPLIED, WITH CATALOGUES AND ESTIMATES, ON APPLICATION TO—

CROMPTON & COMPANY, LIMITED,

MANSION HOUSE BUILDINGS, LONDON, E.C. Works: LONDON and CHELMSFORD.

ELLIOTT BROTHERS,

101 & 102, ST. MARTIN'S LANE, LONDON, W.C.

(ESTABLISHED 1800).

ELECTRICAL ENGINEERS AND MANUFACTURERS OF ALL KINDS OF ELECTRICAL TESTING AND TELEGRAPH INSTRUMENTS.

SUBMARINE MINING APPARATUS, &c. CONTRACTORS TO H.M. GOVERNMENT.

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use. The "street lighter," a transformer, lamp, shade, and brackets complete for one 120 watt lamp, saving more than its first cost in secondary leads. Two 50-light transformers fitted with waterproof cases and brakets for outdoor use. Bridge with switchtop in place of the ordinary plugs, affecting a considerable saving in time and improvement in accuracy. Also a laboratory type of non-inductive wattmeter.

Sydney & Barnet.

Telegraph Manufacturing Company: Electric light cables and wires; telegraph and telephone cables and wires; telegraph and telephone instruments; insulators; telegraph ironwork; castings; batteries.

Thorp, H.; Todman, J. T.; Townley Hookham; Trent Gas Engine Company;

Turvey & Gullete: Telegraph instruments, telephonic apparatus, cheap resistance boxes and bridges, galvanometers, portable ammeters, voltmeters, electric lighting, switchboard, and general apparatus.

Verity & Sons; Victor Primary Battery Company; Vogel, C. F.; Wake & Saunders; Walker, Wm.; Warby, J. L.; Waterlow & Sons; Wells Bros.; Western Electric Company, Limited;

Weymersch Battery Syndicate, Limited: Their primary battery adapted for (1) incandescent lighting—temporary and permanent. (2) Portable lamps (lanterns, miners' lamps, room pedestal lamps, table lamps, &c.) (3) Arc lighting. (4) Ventilating. (5) Pumping. (6) Driving motors for sewing machines, &c.

White James; Wiggins, F., and Sons; Woodley, R.

Woodhouse and Rawson United, Limited: A selection of dynamo and motors, electric crane, switchboard, and specialities in several entirely new designs.

NOTES.

The Roundhay Electric Tramway.—At a recent meeting of the Tramways Committee of the Highways Committee of the Leeds Corporation, Ald. Firth presiding, Mr. Graff Baker, the representative of the lessees of the Roundhay Road and Beckett Street tramways, requested that the lines should be extended from Green Road down Beckett Street to the junction of York Street and Kirkgate, in accordance with the provisional order of 1888. The committee decided to recommend the Highways Committee to make the extension. At the same meeting a deputation from the National Telephone Company attended to complain of an interference with their telephone system by the return current of electricity on the Roundhay Road line. It was stated that since the opening of the tramway a buzzing noise has been noticeable when the telephone has been used, and the deputation even went so far as to assert that it was sometimes possible to tell by the noise when a car was going up a steep gradient. The committee, having heard all both parties had to say, decided to leave the two companies to settle the matter between them.

Electric Light at Maid's Moreton Lodge, Buckingham.—We hear that Maid's Moreton Lodge, the residence of Baroness Kinloss and Captain Morgan-Grenville, has been re-fitted with the electric light. It will be remembered that at the beginning of the present year the fitting of the Lodge with the electric light was announced, but a few weeks after a most disastrous fire occurred on the premises, and Captain Morgan-Grenville at once decided to re-build the portions of the building which had been destroyed. Through the successful installation placed in the Lodge, previous to the fire, Captain Luis Morgan-Grenville (who is a thoroughly practical electrician) again entrusted the drawing up of the plans and specifications to Mr. W. Habgood, electrical engineer, Buckingham, and the result is all that can possibly be desired. Electric bells have also been installed throughout the house.

Electric Light at a Chelmsford Club.—We hear that a highly pleasant and successful gathering in the form of a smoking concert, was held at the Chelmsford Club recently to inaugurate the installation of the electric light upon the premises. As soon as the company were seated, the gas was turned out and the electric light switched on. The installation has been carried out by Messrs. Christy Brothers of Chelmsford, the electricity being supplied from the works of Messrs. Crompton and Company.

Double Barrels.—Can the electrical field of operations have been tilled to such an extent that Woodhouse and Rawson United, Limited, find it more profitable to go altogether outside it to promote a company for producing patent staveless barrels? The *dénoument* of these outside ventures will be awaited with some degree of interest by the electrical fraternity.

Brazed v. Deposited Copper.—Since the Elmore directors' report was made out, the result has been received from Leeds of a trial that has just taken place of an Elmore tube 9 inches in diameter and one-eighth of an inch thick against the best brazed tube obtainable, of similar size, made by the ordinary system. The tests showed that the brazed tube burst in an uneven manner at 448 lbs. pressure The Elmore tube stood 1,456 lbs. pressure, then gave way gradually and evenly. This test, to the initiated, is absolutely valueless. Why were not the tubes tested under steam pressure?

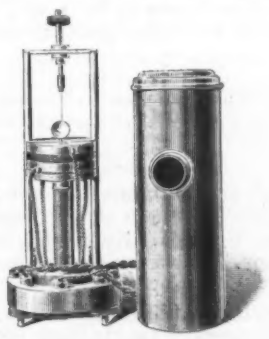
Water Power in Italy.—A company has recently been formed in Milan for the utilisation of about 600 H.P. from the waters of the river Oglio, in the Mulino di Capriolo district, on the Palazzolo-Paratico Railway, in the production of electrical energy which will be transmitted a distance of about 12½ miles.

The New Japanese Parliament House.—The new Japanese Parliament House to replace the one destroyed by fire a short time ago is now completed. The new building, which is a handsome structure, is lighted throughout by electricity.

A Child's Telephone Message.—We have taken the following from *Pick-Me-Up*:—

She wasn't on the play-ground, she wasn't on the lawn,
The little one was missing and bed-time coming on.
We hunted in the garden, we peeped about to see
If sleeping under rose-tree or lilac she might be.
But nothing came in answer to all our anxious call
Until at length we hastened within the darkening hall.
And then upon the stillness there broke a silvery tone—
The darling mite was standing before the telephone,
And softly, as we listened, came stealing down the stairs;
"H'lo, Central! Give me Heaven, I want to say my prayers."

A New Form of Electric Measuring Instruments.—The accompanying illustration shows an electrostatic instrument recently brought out by Messrs. Swinburne and Co. for experimental work in connection with alternate currents. Instead of quadrants there are two pair of half discs so that the angle of deflection can be large. The needle consists of two half discs fastened on a metallic arbor. It is held by top and bottom suspensions. One disc is in the upper box and the other in the lower. The boxes are connected, not to ordinary terminals, but to highly insulated flexibles, as the ordinary terminals are not suitable for high pressures. This instrument can be used as a voltmeter or it may be



connected up to measure power by any of the various methods involving two readings. It can also be connected up as a direct reading wattmeter. The electro-magnet below the boxes acts on a copper drum and renders the instrument dead beat. This magnet is excited by a cell. For large readings the torsion head and pointer on the top of the instrument are used; but for small readings the mirror is employed. Four of these instruments have been lent to Dr. Fleming to carry out experiments on the measurement of power by various different methods.

Electric Light in Publishing Offices.—The publishing offices of the *South Wales Liberal* (Swansea) are lighted by electricity, and are the only newspaper premises in the Principality thus illuminated.

Mumbles and Electricity.—In view of the lighting of the Mumbles by electricity, the Local Government Board has been written to on the subject, and its communication has cleared up certain doubts which existed as to the mode of procedure in the matter. In the event of the local board deciding to make the innovation, it will only be necessary to apply for powers to borrow at the outside £1,000, which it is stated will cover the preliminary installation.

Calendar.—We have received from Messrs. T. Fletcher and Co., of Warrington, one of their calendars for the year 1892. As usual, Messrs. Fletcher have given an illustration of their stoves and gas heating appliances for each day, which seems to us to be a very good way to keep their name and manufactures in the minds of their customers.

Proposed Electric Railway in Sweden.—A company, which already has a concession for the construction of an ordinary steam railway between Stockholm and Djursholm, has petitioned the Government to grant the use of electricity as the motive power instead of steam.

International Competition for a New Battery.—The direction, *L'Elettricita*, of Milan, has opened an international competition for a new electric pile, practical, simple, and industrial. The competition will be open from January 1st to August 31st, 1892. The inventor who comes out first in the competition will be awarded a prize of 2,000 francs. The jury will be composed of competent men. Competitors are asked to take notice of certain conditions, particulars of which can be obtained by writing to the journal referred to.

A Two Thousand-Volt Street Lamp.—Street lighting by alternate current has for some time past presented considerable difficulties. In most cases, transformers are arranged in the houses, and the stations have high-pressure leads only. To run incandescent lamps it is, therefore, necessary, to employ transformers and a system of low-pressure leads. Messrs. Swinburne & Co. have brought out a lamp which contains a small transformer, and is connected direct to the high-pressure system without any low-pressure leads. A 32 C.P. lamp, with protector, is arranged under a large enamelled iron shade, which is secured to the base case of a small transformer. The efficiency of the little transformer is high considering how small it is, being, according to the makers, just under 90 per cent.

Electric Light in a Yorkshire Village.—An offer of Lord Masham, better known as Mr. Lister, of the Manningham Mills, to light the village of Featherstone with electric light, has been accepted by the local board.

Electric Light at Pontypool.—The ratepayers of Pontypool will present a memorial to the local board in favour of the electric light.

Aluminium Accumulators.—A company has been formed in Berlin to be known as the Deutsche Aluminium Akkumulatoven Werk für Elektrische Beleuchtung und Kraftübertragung, to exploit an aluminium accumulator.

The Kimberley Exhibition.—Medals and certificates will be especially awarded for the most economical electric lighting exhibits at the Kimberley Exhibition to be held next year.

The Bernardos Process of Electric Welding.—At the invitation of Messrs. Lloyd & Lloyd, of Birmingham, a number of gentlemen travelled down from London on Monday to inspect an installation of the Bernardos system of electric works at the Coombe Wood Tube Works. We are compelled to defer a description of the most interesting visit.

Kilburn and Electric Lighting.—Messrs. Woodhouse and Rawson have asked the Willesden Local Board whether they would entertain an application to them for a provisional order to supply electric lighting in Kilburn. It was, however, decided by the Board that it would be unwise to take action in the matter at present.

The Electric Light in Spain.—A company has been formed with the view of electrically lighting the town of Murcia, in Spain, and orders for the necessary plant are being given out.

Bishop's Stortford Electric Lighting Order.—At a recent meeting of the Bishop's Stortford Local Board, it was stated that a communication was received from the Board of Trade, informing the Board that the application of Messrs. Ackland and Nockolds on behalf of the undertakers of the above order for an extension of time under section 7, as regarded deposit, had been acceded to by the Board of Trade, who had agreed to the time being extended to June 11th next.

The Electric Light in India.—A handsome pile of buildings are at present in course of erection opposite the large Victoria Railway Terminus at Bombay. These buildings, which are to be the new municipal offices, will be lighted throughout by the electric light. The large Council Chamber will be lighted with three brass wrought electroliers, each containing ten 50 C.P. lamps, making 1,500 C.P. in all.

Bahamas-Florida Cable.—The total length of this cable is 240 knots, 223 knots main type, 10 knots light intermediate type, 5 knots heavy intermediate type, 2 knots shore end type. The core has a conductor weighing 107 lbs. per nautical mile, and the insulation, which is gutta-percha, weighs 140 lbs. per nautical mile. The main cable is armoured with 16/99″ galvanised homogeneous iron wires, the light intermediate with 12/160″, the heavy intermediate with 12/212″, and the shore end with 12/300″. The insulation resistance tested on board ship is 1,464 megohms per knot at 75° Fah, and the inductive capacity ·331 microfarads per knot. The cable will be laid from Nassau in the Bahamas to Jupiter Inlet on the coast of Florida. The contract with W. T. Henley's Telegraph Works Company, Limited, was signed by the Bahamas Government on October 12th last, so that the contractors have lost no time in manufacturing the cable and despatching it to its destination. The cable ship is the *Westmeath*. The engineer-in-chief is Mr. Theophilus Smith; 2nd engineer, Mr. Schischkar; 3rd engineer, Mr. Powell; chief electrician, Mr. Hall; assistants, Messrs. Gedge, Sullivan and Spain.

Football—Silvertown Staff v. Siemens Bros.—This match was played last Saturday at Charlton, before a fair sprinkling of enthusiastic spectators, and resulted in a win for Silvertown by one goal and three tries to nil. The first half of the game was of a fairly even character, but in the latter half Silvertown had matters more in their own hands. In the evening both teams, by the kind invitation of Mr. W. E. Gray, dined at the Holborn Restaurant.

The Electro-magnet in Ophthalmic Surgery.—A few weeks ago we reported a case of successful removal from the retina of a fragment of steel by means of a small electro-magnet; but we find this is by no means the first nor the only case in which this ingenious application of electricity has been made in the surgery of the eye. A number of operations of a similar character are recorded in the transactions of the Ophthalmological Society, in the *British Medical Journal*, and also in a small book on the subject by Mr. S. Snell. These cases have not always been so successful as the one at Cardiff which we recorded, and it seems that a fragment of metal may remain embedded in the retina sometimes with comparatively little disturbance of vision; but as a rule it appears, from what the doctors say, best to attempt removal, and this operation can be performed with the greatest expectations of success by the aid of the electro-magnet.

Electrical Drilling Machines. — A paper on the "Application of Electricity to the Drilling of Metals," was recently read by Mr. Sinclair Couper, at the meeting in Glasgow of the graduate section of the Institution of Engineers and Shipbuilders in Scotland. The author described, by means of sketches, the general construction of electrical drillers, and gave some valuable information respecting the cost and speed of drilling by electricity, as compared with hand drilling.

Lambeth Vestry and Electric Lighting Order.—At a recent meeting of the Lambeth Vestry a letter was read from the House-to-House Electric Light Supply Company, offering to transfer to the vestry the electric order of the company at a price equivalent to the estimated cost of obtaining a new order by the vestry. It was decided that the offer be declined.

BUSINESS NOTICES, &c.

G. A. Nussbaun.—This firm made recently a complete telephone installation at the Adelphi Hotel, Liverpool. The installation comprises three floors, and on each floor a switchboard for 70 directions is fitted. Total number of stations being 210. Each room is fitted with a call box and double "Ader" instrument (magnetic transmitter) as shown in their catalogue, page 2 (fig. 102). A separate call bell and a three-contact pear push which is suspended near the bed, so that the visitors can ring in the usual way or communicate through the telephone. The visitors are able to communicate with one another and with the staff of the hotel. This installation has given great satisfaction, as it is simple and thoroughly reliable. It is made after the large installation at the "Terminus" Hotel at Paris where 350 rooms are connected, the only difference being that the latter was fitted with "Ader" microphones instead of magnetic transmitters. The installation is somewhat after the fashion of the one shown in the firm's catalogue, page 10. Mr. Nussbaum states that all the instruments used in this installation were supplied by "La Société Générale des Téléphones," which he represents; but the installation was carried out by Mr. Langdon, Superintendent of the Midland Railway.

The London Metallurgical Company, Limited.—The London Metallurgical Company, Limited, are using an electrical method of agitating their "Arcas" silver plating solutions. The advantages derived from keeping an electrolyte in motion by some simple means are very considerable. The usual method of employing a rocking frame on rollers has two or three disadvantages: Firstly, it is costly, necessitating shafting and belting; secondly, the liability of the articles to shift on the rods, or to knock against one another. The electrical agitators have been devised to overcome these difficulties. They are easily fixed and adjustable, and entirely overcomes the liability of the plating solution to form into layers of different density, thus causing an uneven deposit. An arm is brought up suddenly and sinks slowly by gravity.

Thomas Fleming, Son and Company. — Messrs. Thos. Fleming, Son & Co., of West Grove Mill, Halifax, have just executed an order for three 10-inch double leather belts for the Gülcher Electric Light and Power Company, Limited, Battersea Foundry, London, which are to drive their new electric light installation at the Crystal Palace. Messrs. Fleming have, at the present time, belts running at the Crystal Palace which were supplied in 1881 for driving all the dynamos there, and these belts have worked continuously during the 10 years without hitch or accident.

The Electric Light in South London. — Messrs. H. F. Joel and Company, of Wilson Street, Finsbury, E.C., are putting up an installation on the premises of M. Joel, bag and trunk maker, Blackman Street, Borough, S.E. Messrs. H. F. Joel and Company have also recently completed an installation in the meat establishment of Messrs. J. Rogers and Sons in Westminster Bridge Road, Lambeth.

Messrs. Sharp and Kent, of 34, Victoria Street, S.W., are installing the electric light in the premises of R. Spurgeon, cloak and mantle warehouse, Newington Causeway, S.E.

Messrs. Dawson and East, electric lighting engineers, are also fitting up an installation at their establishment in Newington Butts, S.E.

Fibrous Battery.—Messrs. George Boor and Company, of 1 and 2, Artillery Lane, Bishopsgate, E.C., have been appointed sole agents for Europe and the Colonies for the new fibrous batteries which are manufactured by Messrs. Thompson and Robertson, of New York.

National Telegraph Works Company, Limited.—We have received a copy of this company's revised and reduced price lists of Leclanché batteries, and we think the information given will prove to be very useful to those trading in these batteries.

Rashleigh, Phipps and Dawson.—Messrs. Rashleigh, Phipps and Dawson, of Berner's Street, W., are fitting the electric light throughout the outfitting establishment of Messrs. Harborow in Pall Mall East.

CITY NOTES.

Elmore's Copper and Wire Companies.

NOTICE is given for the meeting of shareholders in Elmore's Patent Copper Depositing Company, at the Cannon Street Hotel, on the 30th inst., at 12 o'clock. The directors have pleasure in submitting their report, and much satisfaction in announcing the successful completion of the 20-ton plant.

The directors' report is accompanied by a report from the managing director, countersigned by the engineers. It includes an "estimate of the approximate annual profits to be earned." Needless to say, the estimate is very satisfactory. From this report we gather that a further issue of capital will be necessary, in order to bring the output up to 40 tons per week. The directors report does not contain any recommendation to increase the capital by the £50,000 required for that purpose; and, doubtless, the shareholders will desire some further information than the accounts contain before they agree to it. Any information as to the profits on sales of manufactures will have to be extracted from the details of an item in the profit and loss account, as under:—"Balance of factory account, including amount received from Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, for laboratory and experiment expenses, £1,398 17s. 6d."

Notice is given of the meeting of shareholders in Elmore's Wire Manufacturing Company on the 30th inst., at three o'clock, at the Cannon Street Hotel. The directors have the pleasure to submit their report and accounts for the period ending October 31st, 1891. They state that "the period in question has been devoted entirely to the erection of the company's works," and no doubt the shareholders will desire some information in regard to the "output for 1891" for which, when the prospectus was issued, such satisfactory arrangements were made. As the output of 1891 appears to have been *nil* (as we have often hinted that it might be), the shareholders will doubtless learn with less "satisfaction" than the directors "that the whole of the proposed output can be readily disposed of in the form of ribbon or tape, and planished sheet, at a profit considerably in excess of that estimated from the sale of wire spirals."

In consequence of this contemplated ability to dispose of the product in the form of ribbon, the company will apparently not be a wire company at all. The accounts are, as the directors say, "exceedingly simple." Amongst other items they show an expenditure of £111,505 for licenses, £13,000 for land, £41,282 for buildings, plant, and machinery, and £5,268 for administration expenses.

We regret that the accounts and reports of the above Elmore Companies reached us too late to give them the extended notice they require, but attention may be drawn to the absence of information of the prospects of the companies from a commercial standpoint, and the reliance by the directors on the estimates of the managing director, which are much the same as those other estimates which have not been realised.

Elmore's Copper Depositing Company.

THE directors of Elmore's Patent Depositing Company, Limited, have issued the second annual report for the year ending June 30th last. It states:—

"Shareholders are congratulated on the satisfactory technical and commercial prospects of the company. They also submit the statement of the accounts for the year ending June 30th, 1891, which shows a credit balance at the end of the preceding year of £77,825 1s. 4d., from which two dividends of 10s. each, making £1 on each £2 share, were paid. The accounts show credit balances on June 30th last of £14,261 17s. 10d., made up of £5,000 royalties on copper sheets received in advance, £8,558 7s. premiums and profit on land, and balance of profit and loss of £703 10s. 10d., a satisfactory result, considering that the company had only been able to manufacture small quantities of articles at the date of the making up of the accounts—work on a large commercial scale not having been then commenced. The directors have much satisfaction in announcing the successful completion of the 20-ton plant, and thus the programme of work set forth in the prospectus has been carried out. The statements as to the technical features of the process have been entirely proved. Various difficulties connected with the mechanical details of the process, inseparable from the commercial developments of all important inventions, were encountered, which have caused considerable delay. Attention is drawn to the purchase of the Haigh Park Estate, Leeds, consisting of 127 acres of freehold land, on a portion of which site the company's works have been erected. The purchase of this property was rendered advisable by the impossibility of acquiring portions of it required for the purposes of the company and its future extensions, except at the price of £2,000 per acre, whereas the price

actually paid for the whole estate was only £534 per acre, including all expenses. After setting forth the advantages and value of the acquired land, the report further states that negotiations have taken place for the sale of portions at a considerably higher price than that paid. A plot of 13 acres has been disposed of at £1,000 per acre to Elmore's Wire Company, and this price, whilst yielding an excellent profit to the company, is, nevertheless, 50 per cent. below the price demanded for this plot by the former owner, and the directors are advised that they will be enabled to dispose of the whole of the land not required for the purposes of the company, at a similar profit.

A report of Messrs. Elmore's states that the profits of the works, as now completed, are put at over £45,000 per annum, being 30 per cent. upon the present capital of the company, whilst, when the time comes for doubling the output to 40 tons per week, the profits will be increased to over £95,000 per annum, equal to nearly 50 per cent. upon the increased capital that will then be required.

The report concludes with an account of a competitive trial of an Elmore tube against a brazed tube. The tests showed that the brazed tube burst in an uneven manner at 448 lbs. pressure. The Elmore tube stood 1,456 lbs. pressure, being over three times as strong, and then gave way gradually and evenly. Testing machinery had to be specially prepared, owing to the enormous resisting power of the Elmore tubes.

The Wire Manufacturing Company.

ELMORE'S Wire Manufacturing Company, Limited, report, which accounts for the period commencing with the incorporation of the company on March 15th, 1890, and ending on October 31st, 1891, states that the period in question has been devoted entirely to the erection of the company's works upon 13 acres of freehold land purchased from the parent company, and immediately adjoining that company's works. The erected machinery as enumerated is capable of putting out 35 tons a week. This can be readily increased up to 70 tons a week with little additional expenditure above that already incurred. The licences for the making of copper sheet acquired from the parent company is next referred to. Mr. Elmore, managing director, reports that early in the year 1892 the company will be in a position to commence with an output of 35 tons per week. In regard to the accounts, these are exceedingly simple, inasmuch as no trading account having yet been opened, the only outgoings beyond capital expenditure are those occurring under administration expenses, which, however, have been reduced by one-half, largely in consequence of the satisfactory profit derived from a judicious investment last year in Consols and Bank of England Stock.

The Electrical Finance Corporation, Limited.

A COPY of the prospectus of this corporation has been forwarded to us. The objects of the company are to assist local authorities in dealing with the powers granted to them by provisional orders under the Electric Lighting Acts, 1882-1888, &c. In the prospectus use is made, of course, of the phenomenal success of the St. James's and Pall Mall Electric Light Company. The directors are Stephen Alley, Lawrence Heyworth, J. W. H. James, C.E., Charles McCulloch, and John Muirhead, C.E., and the capital is £100,000 divided into 20,000 shares of £5 each, of which 19,800 are ordinary shares, and 200 are founders' shares. The present issue is intended to be of a private nature, and of 6,000 ordinary shares at par, and 150 founders' shares at £5 premium. The remaining 50 founders' shares will be allotted as fully paid to those founders who have borne the preliminary expenses of the company previous to allotment.

Electric Construction Corporation.

A GENERAL meeting of this company was held at Cannon Street Hotel, on Tuesday last; Mr. Spencer Balfour in the chair. After the secretary had read the notice convening the meeting, the

CHAIRMAN, after referring to the report which was published in our last issue, said the duty devolved upon him to propose the adoption of the report, owing to the regrettable absence of their esteemed friend Sir Henry Mance, who had within the last fortnight undergone a very painful operation. He was, however, near convalescence, and in as much as the illness was largely aggravated by devotion to the interests of the corporation, he thought shareholders would agree in wishing him a speedy and complete recovery. He (the speaker) thought he must be grateful that the task had fallen to him, because, in view of the satisfactory character of the report, there would be no difficulty in obtaining the shareholders' approval to the resolution which he should move. He would go briefly through a few of the more striking features of the report, and when that was done he would conclude by making a few remarks on the general prospects of the undertaking. Dealing with the question of profits, and the results achieved during the year, they would see by sales and works executed during the year ended September, 1891, a total of £160,036, that, of course, represented a large figure, and was proof that during the whole year their works had been fairly busy. It meant something like £3,000 a week on work of a manufacturing character alone. The next item in the account was cash and shares for licenses granted, patents sold, and profits upon formation of subsidiary companies. That item of £64,710 was important, and he wished to point out that it represented nearly *all* profit, and was therefore most gratifying. The patents which had been sold were not included in the original purchase from Elwell-Parker, there had been developments of patents, —which at that time were floating through the mind of their extremely able engineer and work director, Mr. Thomas Parker—these patents had been sold, or licenses had been granted to use them. In selling these patents, they had not in any way diminished the securities which were acquired when the works were taken over. They were additional profits and securities acquired since that time, thanks to the genius of Mr. Parker. Out of the sum of £64,710 they had written off no less an amount than £20,000, which was carried to diminution of capital account. He ventured to think that that was a prudent policy, and if they persevered for a few years to come, and if the sales and payments in respect to patents continued, which he had every reason to think they would, the result would be that capital charges would be materially reduced, thus adding largely to the company's capacity to pay a dividend. This year they proposed to write off £20,000, or one-third of the total amount received from the patents, as was mentioned before, to the diminution of capital, and they would see it so appear in the balance-sheet. After that there still remained a profit of £44,790. Referring to the profit and loss account on the other side, shareholders would see that they had debited themselves with £3,099 for depreciation of machinery. They had endeavoured to keep machinery up to the highest point of efficiency possible, and had made two charges for repairs to the working expenditure during the year. In that way they had spent, as they would observe, over £3,000, although at the same time they had deducted £10,000 in profit, and written it as depreciation of machinery, which they would observe, as prudent men, they had adopted a double course, the £10,000 they set aside to meet depreciation of machinery, and they had spent £3,000 in preventing any depreciation of machinery arising. That was a good course, and was a singular course for directors to take. He thought in this respect they might fairly claim to have set an example to every manufacturing company in the City of London. Head office expenses, including directors' fees, salaries, accountancy fees, &c., stand at £11,423 7s. 1d. At the last meeting the amount of office charges was challenged, and he (the speaker) said it would be part of his duty to keep them down as low as possible. Shareholders would observe that for the last year they had amounted to £11,000, as against £14,000 during the previous year. This was a proof, he thought, that he had kept his word to the shareholders, and that the directors were really anxious to keep down the dead charges of the company. Expenses of advertising, issuing debentures, law charges, &c., amounted to £13,000, which was a considerable increase upon the expenditure of the previous year. This was largely owing to the fact that during this year they had issued debentures, and a big debenture issue was not made without expense. The charges for this might have been spread out, if they had chosen, over two or three, or even four years, but they preferred to bring it into the current year's account, and get rid of it once and for all. In addition to that, there were heavy legal expenses which they incurred from time to time in asserting and maintaining the company's position, and asserting and maintaining the position of the patents. He would promise to the shareholders vigilance on the part of the board to keep this expenditure down, but he could not promise, while competition was so keen, and while their opponents were so willing to take every advantage, fair and unfair, of the company, any material reduction on legal expenses. A company of this sort lived by proving its capacity for fighting and its capacity for maintaining the rights of the shareholders in the various properties in which they are interested; to do that they must never be unwilling to fight; that involves expense. They had, he ventured to think, as good, if not better, legal advice than was to be found within the City of London. They got ample value for the money they spent in lawyer's bills, for it was generally the least satisfactory thing a man had to deal with. This resulted in a general profit of £46,000; but of this they had carried £10,000 to reserve, left a net balance of £36,166. They then referred to the transactions during the year, which were some of the most interesting transactions that a board could undertake in dealing with what he would call the electro-chemical patents, for which they were indebted to the marvellous ingenuity of Mr. Parker. He would here take the opportunity to remark that, instead of purchasing, as was often the case, less than was bargained for when they took over the Elwell-Parker business, they had purchased a good deal more than they bargained for. They had derived these electro-chemical patents, which were then not valued at a farthing. So valuable and accruing a possession was this electro-chemical patent, that they thought it wise to place this in the hands of a separate company, and their friend and colleague, Mr. Ebb Smith, who had been managing director of the Electric Construction Company from the beginning, and had practical experience of the negotiations attending this electro-chemical patent, had elected to become the presiding genius of the electro-chemical company. He would mention, as one illustration of the success which had attended the company, in which they were the largest holders, that during the last few days they had sold one of these electro-chemical patents for a sum in hard cash representing close on £30,000, and with a contingent profit of many tens of thousands besides, and this was largely owing to the fact that Mr. Ebb Smith had had time to devote exclusively to working the patents. In business of this sort he considered that they could not have too much subdivision, and the working of chemical patents was quite a business by itself. The vast establishment which they now had at Wolverhampton was quite a business which claimed the energy and occupied the time of the very best men they could place there, and the same applied to electrical storage batteries. They found that they were not holding their own in the storage battery field in doing as much work as they had hitherto done. Mr. Courtney, whose life had been identified with storage batteries, agreed to take up the storage batteries in a separate company, and the result had been that the business has grown, and since it had been placed in separate hands it had yielded a very large profit. Therefore, while union of interests, union of aims, union of working were of the utmost importance, and a vital condition of this company, independent management of independent branches was equally valuable and was equally important. He would here express his thanks to Mr. Courtney for the service which he had rendered to the corporation. Considerable change in the staff had been involved by the re-

tirement of Mr. Ebb Smith, and he was pleased to say that the work was carried out most successfully and economically under the direction of Mr. Samson, and to the benefit of the shareholders. The speaker then referred to the services of Mr. Parker in supervising the establishment at Wolverhampton, and the active part he had taken in perfecting the patents. Mr. Parker was recognised more and more every day as the greatest living authority in manufacturing electricity. Perhaps the biggest electrical work carried out in this country was the Liverpool Overhead Railway, which was to be worked throughout by electricity. The directors had no particular interest in that company, and in an entirely open field Mr. Parker's plans were accepted, and the corporation was now carrying out the contract, from which he believed there would be a large profit. They were dealing with the question of the electric lighting of the City of Oxford, having accepted a contract from the city authorities, and were also supplying the plant to a company formed for supplying electric lighting in the Crystal Palace district. Turning to the balance-sheet, he would just point out again that they set aside £15,000 last year for depreciation and had added £10,000 this year, which made £25,000 as a reserve for depreciation; they had written off their capital account £3,000 for depreciation of machinery, and transferred from profit and loss account £20,000 for the same purpose, while they had reduced their capital charges from £312,800 to £289,700. With regard to the subsidiary companies in which they had taken shares, he found that there was not one of them but which had either paid a dividend or was about to do so. The shares were, therefore, a good investment *per se*, in addition to the advantage to them that they were thus enabled to secure the business which the subsidiary companies were able to bring. He would like to say that since the publication of the report the company had had some very important negotiations with regard to electric traction, having been approached by one of the leading tramway companies, who considered that electricity was to be the motive power of the future, and had offered them a contract which they were now considering. If they should decide to accept the contract—and he believed they would—they would come to the shareholders to secure a further issue of debentures. The company were full of work, and the directors were proud of the operations that had been carried on. They appealed to the shareholders to give them their continued confidence, and he firmly believed they would be able to make the undertaking even more successful than it had hitherto been.

Sir DANIEL COOPER, G.C.M.G., seconded the motion.

Mr. HANCOCK asked for a little more detail in the accounts.

Mr. OELRICH congratulated the directors on the management of the company, and the very satisfactory report they had put before the shareholders. He thought that to declare a dividend of 6 per cent. in the first year, and the same amount in the second, was a very promising state of things in the early days of a company like this.

Dr. DRYSDALE asked whether the tramway to which the chairman had referred as being about to adopt electrical traction was in Loudon. He had been much struck with the progress which had been made in America, and thought it strange that electric traction was not taken up so well in England.

The CHAIRMAN said it was one of the most important companies in the Midlands. Replying to Mr. Hancock, he said it would not be in the interest of the company that everything should be given in detail, because it would be showing their hands too much to their competitors.

The motion was then put and unanimously carried, the dividend, as recommended—viz., 6 per cent., being afterwards declared.

The retiring directors—Sir Henry Mance and Messrs. Ebbsmith, Holt, and Moseley—were re-elected.

Messrs. Broads, Paterson, and Co. were reappointed the auditors.

Mr. WILLIAMS, in accordance with notice, proposed two special resolutions, which were as follows:—"That the directors shall, in conformance with the power given them by Clause 128 of the articles of association of the corporation, pay half-yearly an instalment on account and in anticipation of dividend." "That the directors be requested, with a view to keep the shareholders informed of the position and prospects of the corporation, either to hold half-yearly meetings, or, this failing, to forward to each registered proprietor in April of each year a short *résumé* of the corporation's operations for the previous six months.

The motions having been seconded,

The CHAIRMAN expressed the sympathy of the directors with the spirit of the resolutions, and promised that, as far as they thought it advisable, they would act upon them without any resolutions being passed.

After some further discussion, the resolutions were withdrawn.

Dr. DRYSDALE proposed a vote of thanks to the scientific officers of the company for the way in which they had conducted the affairs of the company, which was seconded by Mr. WILLIAMS, and carried unanimously.

Mr. THOMAS PARKER acknowledged the compliment, and

Dr. DRYSDALE proposed a vote of thanks to the directors, which was also passed, and the proceedings then terminated with a vote of thanks to the chairman, proposed by Mr. GEORGE DIBLEY.

The General Electric Power and Traction Company, Limited.

THE directors' report states that the accounts of the company, up to September 30th, 1891, show a net profit of £2,475 6s. 1d., out of which the directors propose to pay the agreed dividend of 7 per cent. on the preference shares, carrying forward a small balance.

They have pleasure in reporting that the company's business is steadily developing in all the various branches.

The whole sum due to Messrs. Immisch & Co., under the agreement of purchase, has been accepted by that firm in fully paid ordinary shares. The directors have much satisfaction in mentioning this proof of the confidence with which that firm regard the future of this company.

The various branches of the company's business may be classified as follows:—(1) Electric traction. (2) Electric launches. (3) Mining and colliery work, &c. (4) The general application of electric light and power.

1. *Electric Traction.*—The development of electric traction has been somewhat unduly retarded in consequence of difficulties experienced by tramway companies desirous of changing from horse traction to electric power. In many such instances the capital of the tramway companies has been fully expended in the plant necessary for horse traction, rendering it necessary for them, either to raise fresh capital, or to make arrangements for a considerable advance of capital by the electric companies employed. The relations existing between local municipal authorities and the tramway companies have also militated against the immediate employment by the tramway companies of electric traction. The result has been, as regards this company, that although many offers have been made to them to electrically equip various tramlines, it has been necessary to exercise very great caution in accepting even apparently desirable proposals.

We have numerous enquiries from local authorities who are themselves desirous of acquiring the tram-lines for the purpose of operating their cars by electricity. The negotiations respecting this class of business and the estimates and information we have been able to supply justify the hope that this company will secure a considerable order from one of the principal corporations in Scotland.

The working of the Barking Road section of the North Metropolitan Tramways Company's line by this company is still in active operation. This installation has proved of immense value owing to the practical information it affords, and the experiments which can there be practically tested and perfected. By the experience gained in the maintenance of the power, and by this experience alone we have been enabled to quote with safety for large installations for accumulator, overhead and conduit systems.

Arrangements have been completed with the Electrical Power Storage Company, Limited, for the maintenance of the cells on the cars at Barking, as well as for the maintenance of cells, at a fixed rate in the case of new proposed installations. The importance of this as removing a great cause of uncertainty as to the cost of renewal and maintenance, will be obvious to the shareholders.

2. *Electric Launches.*—The electric launch department has made very rapid strides during the past year. Several new boats have been added to the fleet, and the company have built and sold several electric launches and pinnaces. A large and steady development of this department is confidently anticipated.

3. *Mining and Colliery Work, &c.*—Very considerable progress in mining and colliery work has also been effected. Numerous installations have been erected since the company took over the works of Messrs. Immisch & Co., and with recent improvements effected in the application of electric power to collieries, both for coal cutting and the application of the power to mining work, a rapid development of this branch of the company's business should be looked for.

4. *The General Application of Electric Light and Power.*—Numerous electric light installations have been fitted up, and the general manufacturing part of the business continues to make steady progress. The directors are pleased to record a very rapid increase in the number of private installations which have been entrusted to them, especially in the immediate district in which the works of the company are situated.

An agreement has been entered into between this company and the British Electro-Chemical Agency for the purchase of the English and foreign patents of Parker's Copper Deposition Process, and it is your directors' intention to work an electric plant on the Thames, for the refining of copper, a branch of business which has not yet been established in or near London, but which has taken root in the north, and is of a very large profit earning nature.

Messrs. Ward and Wilding, the present auditors of the company, retire, and offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, from January 19th, 1890, to September 30th, 1891.

Dr.	£	s.	d.
To Sundry purchases, expenses and cost of production from January 19th, 1890, to September 30th, 1891, at Kentish Town Works, Barking, and the several river stations, and including Edinburgh and other exhibitions and Windermere ...	63,074	16	11
„ Head office expenses, including rent, insurance, directors' fees, managing director's salary, &c. ...	7,755	14	10
„ Interest on amounts paid up on shares in advance, &c.	179	10	11
„ Balance carried to balance-sheet, being net profit during the period	2,475	6	1
	£73,485	8	9

Cr.	£	s.	d.
By Sundry sales and work executed during the period from January 19th, 1890, to September 30th, 1891, and hire and chargings of launches, &c.	73,034	16	6
„ Transfer fees, discounts and premiums on apprentices received during the period...	450	12	3
	£73,485	8	9

BALANCE SHEET, September 30th, 1891.

DR.	£	s.	d.
To Capital—10,000 preference shares and 25,000 ordinary shares of £10 each	350,000	0	0
Less—1,408 ordinary shares not yet issued, also £4 per share on 9,944 preference shares not yet called up, and calls unpaid	55,191	0	0
	£294,809	0	0
„ Sundry creditors:—On open accounts, on bills payable, and on directors' fees, &c.	9,785	18	11
„ Contingent liabilities:—On claims not finally settled £579 14 7			
„ Profit and loss:—Balance of this account from January 19th, 1890, to September 30th, 1891 ...	2,475	6	1
	£307,070	5	0

CR.	£	s.	d.
By capital expenditure:—For purchase of the businesses of the Electric Traction Company, Limited, and Messrs. Immisch & Co., at Kentish Town, Barking, and the various stations on the river Thames, including all plant, stock-in-trade, book debts, patents, and patent rights, &c., in accordance with the prospectus	242,000	0	0
" Less stock and work in progress and book debts ...	16,017	15	8
	£225,982	4	4
„ Add additional expenditure during the period as follows:—Plant, machinery, &c.	10,610	1	1
„ Launches, boats, charging stations, &c.	9,167	4	6
„ Furniture, trade fixtures, &c.	901	8	1
„ Sundry book debts on ledgers considered good ...	5,574	0	11
„ Stock on hand and work in progress at Kentish Town and other places	30,042	17	4
„ Bills receivable in hand	23,326	11	9
„ Cash at bank and in hand	824	2	6
„ Proportion of expenditure on purchase of business and subsequent expenditure on insurances and rents unexpired carried forward to next account	641	14	6
	£307,070	5	0

We have audited the above balance-sheet and accounts, and certify them to be correct and in accordance with the books and vouchers of the company. WARD AND WILDING.

Bloomsbury Mansion, Hart Street, W.C.

The first ordinary general meeting of this company was held on Friday last, December 18th, 1891. The Earl of Albermarle, A.D.C., K.C.M.G., presided.

The Secretary (MR. THOMAS SMITH) having read the notice convening the meeting, the report was taken as read.

The CHAIRMAN, in his opening remarks, stated that in this instance, in moving the adoption of the report, he had to regret the absence, for unavoidable reasons, of two or three of their directors. He very much regretted their absence, because directors always liked, on the first occasion of meeting their shareholders at the general meeting, to have a full board, and give the full weight of the whole board to the remarks that were made, and to hear the observations that were addressed to them by the shareholders. Lord Egerton, one of their directors, was, unfortunately, obliged to attend a most important meeting of the Manchester Ship Canal, at Manchester, and, as they were aware, they had had a great deal of difficulties to meet, and it was entirely necessary that Lord Egerton, the Chairman of that company, should be present at that meeting, and therefore he was unable to be present at their own. The Chairman stated that Sir Henry Mance was suffering from illness which prevented him leaving the house, so they would excuse his absence. Mr. Paxman was also detained on private business of a very important character, and would be unable to be present; but the Chairman said that they were very much indebted to Mr. Paxman for his constant attendance and the great assistance which he always gave them. He thought it wise to mention these circumstances before proceeding with the few remarks he had to address to them. This was their first meeting, and when rising to address the first meeting it was natural that one should carry one's mind back to the time of the inception of the undertaking which was now under discussion. They began, as the shareholders knew, from very small beginnings. Their numbers were very few, and they did not appeal to the public. Those who had promoted the thing were not professional promoters in any sense, but believers in a form of electricity which he thought they were now gradually seeing the development and success of. They began at Brighton with a small experimental installation, and he was bound to say that on their first inception they committed as many mistakes as was to be expected under the circumstances. Every mistake was an object lesson, as it were; every mistake suggested its own remedy and its own cure, and gradually by dint of never shirking a difficulty, and by never trying to evade or get round it, but by simply meeting it, they found themselves in a position some three years ago to go to one of the most prominent of the metropolitan tramway companies and to tell them that they hoped that they were in a position to show them that electric traction could compete commercially with the horse traction which had hitherto been the rule upon their lines. They were fortunate enough, principally through the instrumentality of Mr. Macpherson who was very intimate with many of the directors of the North Metropolitan Company, to inspire them with a little of their confidence, and the result was that they were allowed to supply electric traction along a small portion of their system, which consists in all of 41 miles. They gave the company up two miles, over which they were to run a certain number of cars under the tramway company's supervision. The arrangement they made with them was that they should pay 4½d, a mile. They were not quite sure at that time what it would cost them, but they were quite certain that the publicity which would be given to electric traction and the success which they hoped would attend their efforts would be fully worth their while, even if they were paid 4½d., for which they contracted, and that amount were exceeded. Part of the arrangement was that they should bear the cost of the expenditure, but that every shilling should be expended under the direct supervision of the North Metropolitan Company themselves, and nothing done without their direct cognisance. They did that in order to appeal to an actually accomplished fact in case of their success, which he was hoping to say had ensued. They were then in a position not to glorify themselves, but to show that they could do this, to appeal to accomplished facts, and to appeal to a case where the statement which they submitted to the public was justified by the facts. For three years they had carried on the Canning Town line, the work of the North Metropolitan Company's tramways. From the very first they met with the greatest kindness from the company, and it encouraged them in their advances, and at least granted them very full confidence, and he hoped to say that they had succeeded very well upon that line; so well, indeed, that in the year 1889 the North Metropolitan Company had found themselves in a position to apply to Parliament for permission to extend over their whole system the principle of electric traction, and that would entirely weigh with the forces. Parliament granted their request, and gave them seven years on a reasonable basis in which they might arrange the necessary capital and pursue their operations. They thought that everything was going well; they had satisfied the company with whom they were contracting; they had inspired them with the same confidence as themselves, and they had obtained from Parliament, as they thought, full authority to extend over a large portion of the Metropolis the advantages of the electric system. Unfortunately the West Ham Corporation were of opinion that they ought to have a veto upon the construction of electric tramways throughout their district of a character which made it quite impossible to proceed with the work under those terms. They said, "Parliament has granted you seven years in order to obtain your capital, and so we have no objections to welcome you amongst us for seven years," and on many occasions the West Ham Corporation said that they were glad to have the pleasure of showing the world electric traction in its full operation. But, he hardly knew how or why they thought it necessary to insert under the Act of Parliament a provision that they should have a veto upon electric traction at 24 hours' notice. They put in that though Parliament had granted seven years; they felt it necessary for their municipal purposes that if at any time during those seven years they should consider electric traction to be in any way objectionable, they should be at liberty to give notice to the North Metropolitan Company to remove the whole of their plant within 24 hours. He need not tell them that with an expenditure of £40,000, which had to be met by the North Metropolitan Company, that they, with any reasonable person, or any body of individuals, would not undertake the onerous responsibility hanging over them with the option of a complicated body, as it must be, that they should be called upon to remove their work within 24 hours. They consequently said that, satisfied as they were that electric traction was a tried success, and had been for two years a success, though they had permission to do so from Parliament, yet, under the circumstances, they must again appeal to Parliament for some modification of the terms under which they would have to act. The company were in that position at the present moment. They had renewed with the North Metropolitan Company the contract in a slightly modified form to work their piece of the Canning Town line, but until Parliament intervened, which he had hopes they were going to be appealed to do in the next Session of Parliament, it was impossible for them to proceed further with that part of their system. They were working without accident, without hitch; they were working at a less expense than others. They had proved their case up to the hilt, and with the unfortunate circumstance at the present moment, they were unable to proceed with that part of their business in London. That, of course, had affected the immediate returns which they might have expected. He pointed out that he was bound to say that it was no discouragement for their directors, and ought not to be so to the shareholders. It was to a certain degree deferring their just expectations, but he thought they would see that it was a matter entirely under Bill of Parliament, and that very kind and accommodating company with which they had had relations, namely, the North Metropolitan Tramways Company. He hoped next year that they would be able to give the shareholders a better account on that point. Referring to traction, naturally when a leading company, such as the North Metropolitan Company, had taken the matter in hand as a test matter, and had to declare to the tramway world whether or no electric traction was a success; any delay on their part naturally influenced the general body of tramway proprietors, and it was found that the General Electric Company had to wait for them as well as the North Metropolitan Tramway. They thought, from the enormous number of applications which were constantly being made to them to introduce electric traction into various towns and countries, that there was a very strong feeling arising among the users of tramways as to electricity being the proper mode to adopt, and many proposals had been made to them to equip tramways in various parts of the kingdom. But they would observe that the general rule with tramway companies was that they had usually locked up almost the whole of their available capital in their horse traction, in their purchase of horses and their maintenance, and in making all their stables and all the preparation for horse traction; thus they had not a great demand of money. Though they desired to go in for electric traction, it could only be obtained by borrowing money. The Electric Traction Company had been asked to supply

the money, but they had thought all along that they ought not to embark the shareholders' money in anything which would be turned into a kind of speculation by advancing money for the purpose of equipping tramways. They had, therefore, turned a deaf ear to any application which involved an expenditure and construction of electric traction installations upon the company, and he hoped that the shareholders would approve of the prudence which the directors had shown on that point. It had somewhat postponed their ultimate success, but it would make it all the more sure that success would arrive eventually. He next turned to another point in their business which had been very largely developed, and which had been very successful to a degree which had given great satisfaction to their directors. He meant pumping in mines and coal mining, which was even more recent than pumping. Electric pumping in mines had been developed to a very considerable extent, and had employed their works in a very satisfactory manner, and with very fair returns. That, like the whole of the electric industry, was still in its infancy, and they hoped to see it very largely developed, for they had very great confidence in it. They had, he believed, a very considerable percentage of all the electric hauling that was done in mines in their hands—he had been told 75 per cent., but would not pledge himself to that. He left that to experts, but he thought that they had a very fair proportion of work that was done by electricity in mines, and from indications which were constantly coming before them, they saw that the mining authorities were getting more and more interested in electricity, and from its feasibility and the economical qualities, they believed that they would have an extension of electrical work. There was another point to which they had considerably devoted their attention, and that was to boats. On that point, he must say that they stood alone. They had got a considerable number of pleasure boats already on the Thames, started by Mr. Immisch, which had been continued and developed by that gentleman's successors in the company. It was daily increasing. They found that foreign Governments were coming to them for electric traction to be supplied to their ships, and they had hopes of the English Government, but the English Government was not so quick in its movements as some other governments were. At any rate, they were acquiring a very considerable amount of confidence in the users of electric launches. They had also gone into the question of the electrolytic deposition of copper, and they found in that respect a very large possibility. From all that he and his colleagues had been able to learn, they found that in entering into that industry they were embarking into something which ought to have very good results. He did not like indulging in prophetic language, but he must entertain considerable confidence in his own mind, and he thought he also spoke for his colleagues, in the probable success for them. They were purveyors of electric lighting plant. Lately, the St. Pancras people round their own immediate works had got an electric lighting installation for lighting their districts, and he might say that the confidence which had been shown by the people in the St. Pancras district, in the immediate neighbourhood of the works of the company had been very great, and they (the company) had been called in for the electrical fitting of a very large proportion of those houses which had adopted the electric light in the district. That was very encouraging, because it showed the feeling which existed between them and their neighbours, and gave those an opportunity of seeing their work. He stated that tramways estimates sent out amounted to £400,000, some of which was in abeyance, in circumstances which he had just described. They had orders to the extent of £150,000 for electric traction for the next year. From the places where corporations themselves had taken into consideration the advisability of adopting electric traction over the municipal tramways, and in those tramways the difficulties that he had described in the case of the West Ham Corporation, and in the case of the tramway companies generally, would not occur. They were in intimate negotiations with some very large corporations who were proposing to alter their mode of traction to electricity; and though it would not do for him to speak with any positiveness about anything which was not actually quoted, the shareholders would see that that was necessary prudence on his part. He hoped next year to be able to give them a very good account on that point of their business. He concluded his remarks by moving that the report and accounts be adopted, and the agreed dividend on the preference shares be declared, and the same be paid on January 22nd, 1892.

Mr. FULLER seconded this resolution, which was carried unanimously.

The next business was the re-election of auditors at a salary of 50 guineas.

Mr. TURNER moved, Mr. C. KING SMITH seconded, and it was carried unanimously.

A vote of thanks, proposed by Mr. EBBSMITH, closed the proceedings.

The Fowler-Waring Cables Company, Limited.

THE third ordinary general meeting of this company was held on Friday last at Winchester House, Old Broad Street, when Mr. W. Fowler presided.

The secretary, Mr. D. Stephen, having read the notice convening the meeting, the annual report, which has already appeared in the ELECTRICAL REVIEW, was taken as read.

The CHAIRMAN: Gentlemen, I have now to move that the report and accounts as delivered be received and adopted, and in doing so I wish to say in the first place that I am sorry Mr. Chamberlain, one of our most active and useful directors, is ill, or he would have been present with us. He writes to say that he wishes me to express his great regret at being absent, and his entire confidence in the future of the company. I have also a letter in the same tenor from Mr. Hardy, who is unavoidably detained in the country. Now, gentlemen, our report is so full as regards the actual position of the company, combined with the report of the manager, that it is not necessary for me to detain you at any length. We have expressed, and I feel it very much, the regret that we have, at not being able to declare a dividend this year, but I can also say that I am not greatly surprised, because this is just one of those businesses that take some time to develop, and therefore we cannot expect to obtain dividends as soon as we might in many other kinds of business. Now all businesses, and especially a business of this kind, depend largely upon the management. When I was here a year ago I expressed my confidence in the management as just then settled. Our present manager had been five months in office at the time we met last year, and I wish again now to express my still more entire confidence in him and my sense of the energy and ability which he has used in the management of the affairs of the company. And I think those who know him outside the company will not be surprised at my making that statement. Now you will say "That is all very well, but we want to know what you think about the prospects of the company." Well, gentlemen, I expressed myself with satisfaction last year as to the future prospects, and what I then said has been, I think, well borne out. We have had a great increase in the business of the company and we see before us immediately, I think, a still further increase and I have really great hopes—I think I may say expectations—that if we all live and are well this time next year we shall have something very satisfactory to report, and not merely to report but to divide, which is a great deal more satisfactory. We are having large additional orders coming in at the present time, and the contracts are numerous and very important. I think I am very careful in whatever I say about the position of the company, and I would not hold out anticipations that are not likely to be realised. But I have every confidence that this company, notwithstanding all the peculiar difficulties that it has to meet in the great competition, in the continued changes that take place in the inventions in electrical affairs, notwithstanding all these peculiar difficulties, I believe, with the kind of management we have now, that the coming year will be a prosperous one, and I hope, indeed, we shall have many prosperous years. I do not think I need detain you with any more details, the accounts speak for themselves. We have explained everything on the face of them, and every shareholder who has read them will understand them, but if there should be any question that occurs to any shareholder, I shall be only too happy to answer it. I repeat my great regret that we have not something to give you at this time, but still I can say I have every confidence in the future of the company. I beg to move that the report and accounts be adopted.

Mr. G. FLEMING seconded the motion, which was carried unanimously.

The CHAIRMAN then moved the re-election of the retiring directors, Messrs. W. Chamberlain and R. W. Eddison.

Mr. R. S. WARING seconded the motion, which was agreed to.

Mr. MCINTOSH proposed the re-election of the auditors, Messrs. Cooper Bros., & Co., which was seconded by Mr. Smart, and agreed to.

The CHAIRMAN: That is all the business, gentlemen; I should just like to say that Mr. Eddison has lately been in America and has spent a great deal of time, and I think very usefully, in the interest of the company, finding out just what is going on and obtaining some information which will be of great value to us.

The proceedings then terminated.

The Gülcher (New) Electric Light & Power Company, Limited.

A MEETING of the Gülcher (New) Electric Light and Power Company, Limited, was held last Friday at Winchester House, Old Broad Street, E.C. The secretary having read the notice convening the meeting, the chairman stated that the board wished the shareholders to give their sanction to the adjournment of the meeting for two months to enable them to complete all the usual business of the company. The principal reason for adjourning the meeting was, as we announced last week, because the company's chairman (Mr. De Castro) was on his way back from New Zealand, and the directors wished to wait until he returned so as to have a full report of the results of his visit. The chairman then formally proposed the resolution adjourning the meeting.

Mr. GRAVING seconded the motion, and it was carried.

The proceedings then terminated.

Eastern and South African Telegraph Company, Limited.—The Eastern and South African Telegraph Company, Limited, notify that the coupons due on January 1st, 1892, on their 5 per cent. mortgage debentures will be paid on and after that date, at the banking house of Messrs. Barclay, Bevan and Co., 54, Lombard Street, E.C. Coupons should be left at the bank three clear days for examination.

Electric Installation and Maintenance Company, Limited.—The name of this company was changed on Saturday last to the Crystal Palace District Electric Supply Company, Limited.

West African Telegraph Company.—The West African Telegraph Company announces a dividend of 3s. per share for the half-year ended June 30th last.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for last week amounted to £788.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Dec. 17th.)	Closing Quotation. (Dec. 23rd.)	Business done during week ending (Dec. 23rd, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	102	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	94$\frac{3}{4}$	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	88$\frac{3}{4}$	88
2,849,510*l*	Do. do. Deferred	Stock	13 — 13$\frac{1}{2}$	13$\frac{1}{4}$— 13$\frac{3}{4}$	13$\frac{1}{8}$	13
130,000*l*	Brazilian Submarine Telegraph, Limited	10	11 — 11$\frac{1}{2}$	11 — 11$\frac{1}{2}$	11$\frac{3}{8}$	11$\frac{1}{8}$
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	101$\frac{1}{2}$	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	104 —108	104 —108	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3$\frac{1}{2}$— 3$\frac{3}{8}$	3$\frac{1}{2}$— 3$\frac{3}{8}$	3$\frac{1}{16}$	...
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2$\frac{1}{4}$	2 — 2$\frac{1}{4}$	2$\frac{1}{8}$	...
40,000*l*	Chili Telephone, Limited, Nos. 1 to 40,000	5	3$\frac{1}{2}$— 4$\frac{1}{2}$	3$\frac{1}{2}$— 4$\frac{1}{2}$	...	...
50,000*l*	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	2$\frac{1}{2}$— 3$\frac{1}{2}$	...	...
30,152*l*	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	6	5$\frac{1}{2}$— 6	5$\frac{1}{2}$— 6	5$\frac{7}{8}$	...
$7,716,000	Commercial Cable, Capital Stock	$100	145 —148	145 —148	...	...
224,850*l*	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	$\frac{3}{8}$— $\frac{1}{2}$	$\frac{3}{8}$— $\frac{1}{2}$	...	...
100,000*l*	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	5	5$\frac{1}{2}$— 6	5$\frac{1}{2}$— 6	5$\frac{7}{8}$	5$\frac{3}{4}$
16,000*l*	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000*l*	Do. do. 10 p. c. Preference	10	16 — 17	16$\frac{1}{2}$— 17$\frac{1}{2}$	16$\frac{3}{4}$	...
12,931*l*	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3$\frac{1}{4}$— 3$\frac{3}{4}$	3$\frac{1}{4}$— 3$\frac{3}{4}$	...	...
6,000	Do. do. 10 p. c. Preference	5	9$\frac{1}{2}$— 10$\frac{1}{2}$	9$\frac{1}{2}$— 10$\frac{1}{2}$	10	...
60,710	Direct United States Cable, Limited, 1877	20	10$\frac{7}{8}$— 11$\frac{1}{8}$	10$\frac{7}{8}$— 11$\frac{1}{8}$	11$\frac{1}{16}$	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14$\frac{1}{4}$	14 — 14$\frac{1}{4}$	14$\frac{3}{16}$	13$\frac{15}{16}$
70,000	Do. 6 p. c. Preference	10	14$\frac{3}{4}$— 15$\frac{1}{4}$	14$\frac{3}{4}$— 15$\frac{1}{4}$	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	109	108
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15$\frac{1}{4}$	15 — 15$\frac{1}{4}$	15$\frac{3}{16}$	15
78,300*l*	Do. 5 p. c. (Aus. Gov Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	107 —110	107 —110	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	101$\frac{1}{2}$	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6$\frac{1}{2}$— 7	6$\frac{1}{2}$— 7	6$\frac{3}{4}$	6$\frac{9}{16}$
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ..	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1$\frac{7}{8}$— 2$\frac{1}{8}$	1$\frac{7}{8}$— 2	2	1$\frac{13}{16}$
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2$\frac{3}{4}$— 3	2$\frac{1}{4}$— 2$\frac{3}{4}$	3	2$\frac{5}{8}$
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd	2	1$\frac{7}{8}$— 2$\frac{1}{8}$	1$\frac{3}{4}$— 2	1$\frac{7}{8}$	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9$\frac{3}{4}$— 10	9$\frac{3}{4}$— 10	10	9$\frac{13}{16}$
180,042	Do. do. 6 p. c. Preference	10	14$\frac{3}{4}$— 15	14$\frac{1}{4}$— 15	15	14$\frac{7}{8}$
150,000	Great Northern Tel. Company of Copenhagen	10	18$\frac{3}{4}$— 19$\frac{1}{4}$	19 — 19$\frac{1}{2}$	19	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8$\frac{1}{2}$	8 — 8$\frac{1}{2}$	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9$\frac{1}{2}$— 10$\frac{1}{2}$	9$\frac{1}{2}$— 10$\frac{1}{2}$	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20$\frac{1}{2}$— 21$\frac{1}{2}$	20$\frac{1}{2}$— 21$\frac{1}{2}$	20$\frac{5}{8}$	20$\frac{3}{4}$
200,000*l*	Do. do. 4$\frac{1}{2}$ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42$\frac{3}{8}$	42
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ...	10	4 — 5	4 — 5	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8$\frac{3}{4}$— 9$\frac{1}{4}$	8$\frac{3}{4}$— 9$\frac{1}{4}$	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9$\frac{3}{4}$— 10$\frac{1}{4}$	9$\frac{1}{2}$— 10	9$\frac{15}{16}$	9$\frac{13}{16}$
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4$\frac{3}{8}$— 4$\frac{3}{8}$xd	4$\frac{3}{8}$— 4$\frac{3}{8}$xd	4$\frac{9}{16}$	4$\frac{7}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	12$\frac{1}{4}$— 12$\frac{3}{4}$xd	12$\frac{1}{4}$— 12$\frac{3}{4}$xd	12$\frac{3}{8}$	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12 — 12$\frac{1}{4}$xd	12 — 12$\frac{1}{4}$xd	12$\frac{1}{2}$	12
420,000*l*	Do. 4$\frac{1}{2}$ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109	107 —109	108	...
250,000*l*	Do. (issued at 5 p.m., all paid)	25	29 — 32	29 — 32	30$\frac{1}{4}$	...
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	6$\frac{1}{2}$— 7$\frac{1}{2}$	6 — 7	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	$\frac{9}{16}$— $\frac{5}{8}$	$\frac{3}{16}$— $\frac{5}{16}$	...	...
9,000*l*	Reuter's Limited	8	7$\frac{3}{4}$— 8$\frac{1}{4}$	7$\frac{3}{4}$— 8$\frac{1}{4}$	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8$\frac{1}{2}$— 9	8$\frac{1}{2}$— 9	8$\frac{7}{8}$	8$\frac{1}{2}$
7,900	Do. do. do. 7 per cent. pref.	5	7$\frac{1}{4}$— 7$\frac{3}{4}$	7$\frac{1}{4}$— 7$\frac{3}{4}$	7$\frac{1}{2}$	...
3,381	Submarine Cables Trust	Cert.	117 —122	117 —122	...	...
78,949	Swan United Electric Light, Limited ... ... (£3$\frac{1}{2}$ only paid)	5	4$\frac{1}{4}$— 4$\frac{3}{4}$	4$\frac{1}{4}$— 4$\frac{3}{4}$	4$\frac{9}{16}$	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43$\frac{1}{2}$	42$\frac{3}{4}$
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	...	...
30,000	West Coast of America Telegraph, Limited	10	3$\frac{1}{2}$— 4$\frac{1}{2}$	3$\frac{1}{2}$— 4$\frac{1}{2}$	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	100 — 105	100 —105	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10$\frac{1}{4}$— 10$\frac{3}{4}$	10$\frac{1}{4}$— 10$\frac{3}{4}$	10$\frac{3}{8}$	...
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7$\frac{1}{2}$	6$\frac{1}{4}$— 6$\frac{3}{4}$	6$\frac{1}{4}$— 6$\frac{3}{4}$	6$\frac{7}{16}$	6$\frac{5}{16}$
30,364*l*	Do. do. do. 5 p. c. Deferred	7$\frac{1}{2}$	4 — 4$\frac{1}{2}$	4 — 4$\frac{1}{2}$	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1$\frac{1}{2}$— 1$\frac{3}{4}$	1$\frac{5}{8}$— 1$\frac{7}{8}$	1$\frac{3}{4}$	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	8$\frac{3}{4}$— 9$\frac{1}{4}$	9 — 9$\frac{1}{2}$	9$\frac{1}{2}$	9$\frac{1}{8}$
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	7 — 8	7$\frac{1}{2}$— 8$\frac{1}{2}$	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102	98 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6$\frac{1}{2}$— 6$\frac{3}{4}$	6$\frac{1}{2}$— 6$\frac{3}{4}$	6$\frac{1}{2}$	6$\frac{7}{16}$

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6$\frac{1}{2}$ paid) 7$\frac{1}{2}$—7$\frac{3}{8}$.—Electric and General Investment, Shares of £5, £1 paid, 2$\frac{3}{8}$—3$\frac{1}{4}$.—European Sims-Edison Torpedo Company, shares of £20, fully paid, 20—20$\frac{1}{2}$.—Halifax and Bermuda Cable, 4$\frac{1}{2}$ per cent. bonds, 85—95.—House to House Company (£5 paid) 4$\frac{1}{2}$—5.—†Liverpool Electric Supply, Shares of £5, £3 paid, 2$\frac{3}{8}$—2$\frac{7}{8}$. Shares of £5 (fully paid), 4$\frac{1}{2}$—5$\frac{1}{2}$.—London Electric Supply Corporation, Ordinary (£5 paid), 1—1$\frac{1}{8}$. Do. 6 per cent. Preference, 1$\frac{3}{8}$—2$\frac{1}{4}$.—Manchester, Edison and Swan Company, £9 (£1 paid), $\frac{1}{2}$—$\frac{5}{8}$.—National Telephone Debentures, 2$\frac{1}{4}$—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2$\frac{1}{2}$—2$\frac{3}{8}$.—£5 Preference, fully paid 3$\frac{3}{8}$—3$\frac{7}{8}$.—Wards Electric Car, £10 paid, $\frac{3}{4}$—1.

† Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3$\frac{1}{2}$ per cent. (December 10th, 1891).

THE HEILMANN ELECTRIC LOCOMOTIVE.

IN a recent issue of the REVIEW, a brief description was given of the system of electric traction devised by M. J. J. Heilmann. This method differs from others previously sketched out, in so far that the current is produced on the train according to requirements, no fixed conductor being employed. A company has now been constituted to promote this system in Paris under the title of the Société Anonyme de la Traction Electrique, with a capital of 300,000 francs (£12,000), and with headquarters at 30, Rue de Grammont.

It will be remembered that the original scheme provided for the generation of the current on the front vehicle or locomotive, and for its passage to motors arranged throughout the length of the train. This project would have necessitated considerable expense, as a complete train would have had to be built, and the inventor has therefore modified his system, which is to be experimented with on the Chemin de Fer du Nord. Mr. Heilmann informed a correspondent last week that he is not prepared for the present to publish drawings of his electric locomotive which forms the modification of his system.

The locomotive, the construction of which is now nearly completed, is 15 metres, or say, 50 feet long, and its head is formed in the shape of a prow to reduce the resistance of the air. It is mounted on two bogie trucks, each of which has four axles provided with wooden wheels 3 feet 4 inches in diameter. Arranged upon each axle is a three-phase motor of the Brown type, to which the current is conveyed by three conductors. The armature revolves, and by means of rubbing contact pieces a variable resistance can be inserted in the circuit to regulate the speed.

The boiler is carried in the rear of the locomotive, and is of the Lentz type. It is capable of supplying steam to an engine of 600 H.P. The engine, which is of the horizontal type, has tandem cylinders; is arranged to work at 180 lbs. pressure, and the average speed is 300 revolutions per minute. The shaft of the engine is coupled direct to the generating Brown three-phase dynamo. A second engine is provided to drive a small continuous current dynamo, which is used for exciting the large machine and for lighting purposes. On the front of the locomotive is arranged the driving platform, where the driver has within easy reach the controlling and regulating switches and compressed air brake handles. Water tanks and coal stores are arranged on each side of the boiler, so that the locomotive also forms the tender. The locomotive, as already mentioned, is to be shortly tested on one of the lines of the North of France Railway Company, and the promoters of the system anticipate that the Heilmann electric locomotive will prove as economical as an ordinary steam locomotive.

THE ELECTRICAL WORKS AT GABLONZ.

[FROM OUR OWN CORRESPONDENT.]

THE town of Gablonz, in Bohemia, has been for some time possessed of electrical works which are carried on by an undertaking under the style of Mahla, Hoffmann & Co., and deserves notice, as they are about to be worked by means of accumulators. Hence it appears likely to furnish further information on the behaviour of accumulators in central stations. The accumulators are on the Tudor system, which is being very zealously pushed by those firms which represent the continuous current system in Austria-Hungary. It is to be hoped, in the interest of the cause, that the working results of this establishment, as obtained with accumulators, will be given unmodified to the public, in order that it may at last have the opportunity of forming a conclusion on authentic grounds which of the conflicting statements on the technical and commercial value of accumulators is in accord with facts. Concerning the construction of these electrical works, the following details are taken from the Gablonz local papers :—

The works are combined with an industrial establishment already existing at Brandl, a small hamlet bordering on Gablonz, whereby both the installation and the working expenses are considerably reduced. Such very practical combinations of electric works with industrial establishments already existing have for some time met with especial approval in Austria-Hungary, and are projected in many places. This idea certainly deserves imitation, as it promotes the development of electrical works, since it is thus practicable to conduct works economically where the erection of electric central stations with buildings erected for the purpose, and with an independent staff, would be unprofitable.

The machinery station is in the workshop of the firm Karl Hoffmann and Sons, at Brandl. For the present, two continuous current dynamos and a reserve dynamo have been erected, each of 60 H.P., which, exclusive of the reserve machine, are able to feed 1,000 glow lamps.

The accumulator station is in a house which has been specially built in the Neubaugasse. The battery of accumulators consists of two series each of 86 elements, which are charged on the two-lead system, discharged on the three-lead system, and are capable of independently feeding 750 glow lamps for five hours. Both stations can therefore effect the service of 1,750 lamps burning simultaneously.

The supply-leads consists of a two-lead system of copper cable, well insulated with a double coating of lead, and, in addition, with a compound sheath of hemp tissue saturated with non-conductive mass. All the cables, both of the supply leads and of the distributive net were laid down in strong wood channels, saturated with creosite, covered with melted asphalt, and closed with wooden lids.

The distributive leads pass for the present from the accumulator house in two sets of three leads each and ramify hence over a considerable part of the town. One triple conductor (two circuits with two so-called outer conductions and a common departure conduction for the one and a return for the other circuit) leads from the Neubaugasse through the Marktgasse to the Old Market, past the savings bank to the switch-box, at the corners of the Gebirgstrasse, and the Old Market; thence through the main street as far as the Hotel Krone. Branches pass from the Old Market upwards to the corner of the Schulgasse and on to the main road, and from the first switch-box through the Steinstrasse across the New Market to the corner of the Göthegasse and from there to the Gebirgstrasse. A branch from the second switch-box leads through the Town Hall Street across the New Market, through the New Market and through the Josefstrasse up to the Catholic Church. The opposite corners of the New Market are connected with each other.

The other triple conductor leads from the accumulator house through the Mozart-gasse and the Gebirgstrasse to the offices of W. Klaar. Branches pass through the Mozartgasse through the Humboldtgasse to the Gebirgstrasse, also from Jeiteles offices to the ice run over the Neisse, the Thalstrasse down to the new bridge from the Gebirgstrasse into the Schillergasse, and on the other side into the Pearlgasse up to Müller's restaurant.

Each district along the net can be connected for lighting and power on conditions laid down by the company.

The installation has been carried out by Kremenetzky, Mayer & Co.; the accumulators by the Joint Stock Accumulator Works (Vienna?), and the cables by the firm A. Jacottat and Co., of Vienna.

ELECTRIC LIGHTING OF STEAM CARS.

ABOUT a year ago the inauguration took place in the environs of Paris of a new service of steam tramcars on the Franck fireless locomotive system, the line extending from the Arc de l'Etoile to Saint-Germain. The locomotives receive their store supply of steam at two depôts near the extremities of the line, at 45 lbs. pressure, and this is reduced and furnished to the cylinders at about 14 lbs. Each train consists of a locomotive, a goods car immediately behind, and from two to five first and second-class passenger cars, according to requirements. A system of heating all the cars in winter has been introduced, and the electric light has also recently been adopted.

The current is supplied by two batteries of each 14 cells, connected in series, and placed in boxes arranged on each side of the cars. The cells are of the Julien type. Lamps of 15-C.P. are used for the lighting of the cars, and the current passes from one car to the next along a two-wire cable terminating in an ingenious contact-piece devised by M. Grivolias, and which answers all requirements in the

handling of the vehicles. This contact comprises two pieces — one male, and the other female — arranged to be connected with similar contacts on the next car. This arrangement is considered to be better than that of having the same kinds of semi-contacts on both sides, whilst at the same time the connection between two vehicles can only be severed by pressing a button. The charging station, which is at one of the depôts, contains a Julien dynamo, giving 40 ampères at 140 volts, when driven at 1,400 revolutions by a Davey-Paxman compound engine. A special charging platform, where eight batteries can be dealt with simultaneously, is provided, and here the changing of the cells takes place.

The glow lamps in use are of the Khótinsky type, and in addition to these, electric bells are fitted in the cars. A second dynamo is employed for lighting up the depôt with both arc and incandescent lamps. The lighting of the cars is said to be very satisfactory.

REVIEWS.

Central Station Management and Finance. By H. A. FOSTER. C. C. Shelley, College Place, New York; H. Alabaster, Gatehouse & Co., *Electrical Review* Office, 22, Paternoster Row, London.

The contents of this book are based upon a series of articles prepared by the author at the request of the editors of the *Electrical Engineer*, and published in that journal during the present year. It has been the aim throughout to develop a practical plan applicable to the vast majority of central stations in this country, and to lay down rules not only for a good scheme of organisation, but for a satisfactory basis of account-keeping. The text embodies a large number of forms, blanks, sheets, registers, tickets, labels, analyses, &c., such as have been in actual use by the writer, and the regular employment of which has added greatly to the efficiency and earning capacity of central stations with which he has been connected. Interspersed in the text will be found many hints and suggestions that deal with station operation, and that bring out the close relationship between sound engineering and scientific bookkeeping. In a station that is properly conducted, the system of organisation that is established in the dynamo room and the engine room will run through to the last figure of its balance-sheet. The hands of the superintendent or electrical engineer will be strengthened by the knowledge he enjoys of the manner in which his work is telling day by day in higher economy of operation and in the growing margin of profit. While almost any of the blanks may be used individually, the author earnestly recommends a close adherence to the general scheme he has worked out. To the managers of central stations in England we cordially recommend this valuable little work.

*Lubrication of Machinery and of the Rolling Stock on Railways.** By ET. VERNY. Paris: G. Carré.

The author of this work undertakes to discuss certain novel appliances and procedures for lubricating machinery by means of which the wear and tear due to friction is suppressed and the waste of motive power and of oil is reduced to a minimum. He next considers the means employed for securing the greased surfaces against dust, even where it is most intense. He proposes a new dynamometric method for the assay of lubricants and the determination of their standard or lubricating degree.

This dynamometric method he proposes to apply to ascertain the coefficient of friction for various lubricants on hard or soft alloys, for the determination of the power wasted corresponding to the wear and tear of the crank-pins and bearings occasioned either by insufficient lubrication or by the clotting of the oil, &c. He then passes to a comparative trial of the various methods and appliances employed for greasing machinery and to the direct measurement of the force absorbed by every machine in action.

It will be seen that the author pays little attention either to the original acidity of an oil or to its power of taking up oxygen and becoming acid and resinous. These bad properties and their degree cannot, of course, be ascertained by any machine, but require a chemical examination which is conducted upon a small sample.

There is an appendix to the work which treats of the stability of the universe and perpetual evolution.

We are somewhat staggered to find questions of transcendental physics and chemistry discussed as a tail-piece to a work on wheel grease. Upon the genesis of matter M. Verny throws no new light, or rather he does not state very definitely what views he holds. But he is evidently hostile to organic evolution and can hence scarcely be expected to regard with favour the ideas which have been put forward concerning the origin of our accepted elements. Without any wish to be discourteous we must gently remind him of the old proverb: "Ne sutor ultra crepidam."

* *Graissage des Machines et du Matériel roulant des Chemins de Fer.*

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, CARDIFF, 1891.

REPORT OF COMMITTEE ON THE PHENOMENA ACCOMPANYING THE DISCHARGE OF ELECTRICITY FROM POINTS.

(*Concluded from page* 684.)

Effect of Curvature of Discharging Surface.

Section 4.—Two conclusions appear, then, to result from the foregoing. In the first place, the absence of discharge below a certain definite potential, which is constant for given conditions, implies the breaking down of some resistance before electricity can pass off at a point; and, secondly, the fact that f is independent of d points to the near neighbourhood or actual surface of the point as the seat of this resistance.

All this is in accordance with what is known regarding the discharge of electricity in gases, and is indeed only what one would naturally have expected. It still remains to consider whether the resistance to discharge is to be sought in the gas itself, in the surface of the point, or in both.

The possible ways in which resistance may arise are, I think, all to be included under three heads:

(*a*) It may exist in the gas itself, to a greater than molecular distance from the point. For this the gas must become possessed of something in the nature of structure round about the point—*i.e.*, cease to be gas in the ordinary sense of the word—and the only kind of structure that suggests itself as likely is that of the polarised Grotthuss chains, which Prof. J. J. Thomson has used with such effect in his beautiful theory of striæ.

(*b*). It may exist at the surface of the metal only, and consist in the tearing away from the point by electrical force of electrified particles which are clinging to it (a special case of which is the forcing of charged particles through a non-conducting layer on the point.)

(*c*). Or it may mean the pulling off of something in the nature of a film possessing surface-tension.

As a matter of fact (*b*) and (*c*) are two opposite extremes of the same phenomenon. In both, particles adhering to the point are pulled off, but the adhesion (*b*) is normal to the surface only—*i.e.*, between the particles and the metal—while in (*c*) it is tangential to the surface only—*i.e.*, between the particles themselves. An actual case would lie somewhere between the two, and probably much nearer to (*b*) than to (*c*).

Now in the case (*a*) of Grotthuss chains the field, f, at the point, as measured by the pull upon it, should increase as the sharpness of the point increases; and for two reasons. In the first place, for chains of given length there will be some average strength of field required to break them, the value of which will always be less than that measured at the surface of the point on account of the divergence of the lines of force there; and the difference between the measured and the average field will be more marked as the divergence —*i.e.*, the sharpness of the point—increases. Secondly, the chains will be shorter at a sharp point than at a blunt one on account of this same divergence; and this again will necessitate a stronger field to break them, for much the same reason that a short piece of iron is harder to magnetise than a long one.

The same sort of variaton of f with sharpness of point will occur in the case of (*c*), if the mechanical pull of the field on the point-surface be looked on as having to tear off a film stretched over it.

But to pull small particles off a point whose radius of curvature is large compared with their diameters will always require the same value of f. Hence (*b*) differs from (*a*) and (*c*) in requiring that f shall be independent of r.

The effect on f of altering r was therefore investigated. Steel needles were ground by a watchmaker to hemispherical points of different diameters and burnished with a hard steel-tool. The values of f in air were then determined for each at various pressures; the instrument used being the smaller of the two described in section 8. Curves connecting air-pressure, p, and f were then plotted, and from these the numbers given in Table II. were taken. The values of f for positive discharge are given for three pressures—76, 40, and 20 centi-

metres of mercury. Those for negative discharge are only given as 20 centimetres. The reason being that the latter show a good deal of irregularity at high pressures, seeming as will be seen later, to depend largely on the condition of the point-surface, which the positive values do not. The values of f for needle C are inserted with queries, as they are almost certainly too high. The extreme fineness of its point necessitated a very rapid tapering to the sharpest part, so that a good deal of the measured pull must have been due to lines of force starting from its sides. This is borne out by the numbers in the four last columns.

Now, these columns show that below a point radius of $\frac{1}{10}$th millimetre, f varies in close proportion with $r^{-0\cdot8}$, and they consequently negative hypothesis (*b*). But they also negative (*c*), for the pull per square centimetre normal to a film of surface-tension, T, and radius of curvature r necessary to break it is proportional to T/r, and if this pull is to be supplied by f it follows that f^2 must be proportional to T/r, which gives $-0\cdot5$ instead of $-0\cdot8$ as the power of r with which f varies. Even $-0\cdot5$ is higher than can be assumed, for it is calculated on the supposition that there is no cohesion between the film and the point, and the existence of cohesion would still further reduce the power of r, as tending to bring the film nearer to class (*b*).

Resistance to discharge at a point is thus to be found in the surrounding gas, and is, therefore, practically reduced to the breaking down of Grotthuss chains, the length of which are not negligible compared with the radius of curvature of the point. I do not mean by this to exclude surface-resistance as a possible factor in discharge —indeed, what follows shows that it may be very appreciable; but it is not the whole, nor, I believe, an important part, of the resistance at a clean point.

Section 5.—After a point has been used for discharge for some time its resistance increases greatly, and when discharge occurs it begins with a suddenness and violence which is very suggestive of the bursting of a film. The effect is increased if the point be now re-burnished (without regrinding), though this process makes it look as if it had never been used. For instance, curves II. are those connecting the pressures of the air with f for needle H. The continuous curve, A B, represents f at the commencement of positive discharge, C D being for negative. The readings for these two curves were taken alternately, two at a time, the pressure being gradually increased. They correspond to an unused clean needle. The cloud of points (o for positive and × for negative discharge) was obtained on attempting to repeat the curves, and it was noticeable that each repetition increased the values of f, though the needle was well polished on dry wash-leather and rouge each time. Afterwards the needle was re-burnished, and the dotted curves, E F (+) and G H (−) obtained, showing a still further increase of f and no less irregularity in its values than before.

The above, therefore, furnishes evidence of the growth of resistance at a point where it is used. That the current does not permanently clear the formation away in getting through is obvious from the readings; but if a reading be taken quickly after another with a point in this condition, the second value of f is often slightly lower than the first; as if the film had not had time to finish forming again after the first discharge. Now if this were so it would follow that the value of f, when the current stops, should be less than when it starts (for a used point only; the two values agree closely for a clean one). To test this, needle H was again taken and the values of f determined for various air-pressures at the point when the current just stopped, the potential of the needle being gradually diminished until a high resistance (7,000 ω) Elliot galvanometer between the needle and the earth stood at zero. The results are given in curves III. A B and C D for the unused point are repeated from curves II. for comparison. J K and L M are the new curves. They are marked by circles. The agreement between J K and A B could not be closer, and points unmistakably to a *temporary* cleaning of the point while current is flowing. L M, for negative discharge, is very curious—coinciding as it does with C D at low pressures, while it leaves it so completely higher up. It was noticeable that just in proportion as the two curves diverged, the stoppage of the current was marked by increasing suddenness. At high pressures it was impossible to get the needle to discharge at all with a small current; either the flow was strong or it stopped altogether with a jerk—the same effect, though almost microscopic, being just perceptible at the cessation of positive discharge also. This being so, it follows that the values of f on the negative curve really correspond to a strong current and not to the point where the current stops. Hence their greater values. The sudden cutting off of the negative current was very striking, and suggested rather forcibly the covering over of the point by some sort of film that had been perforated by it. It is true that the positive discharge was hardly affected, but this is only an example of what has been already alluded to—the relatively greater instability of negative than of positive discharge.

Although the silent discharge from a point does not appear to have the power of permanently clearing away surface-resistance, sparks do so readily enough—though under suitable circumstances they will also form it again. In making the measurements on needle B (Table I.), the discharge at the last recorded (+) reading took the form of a spark. $\sqrt{P}$ was here 1·59. On repeating the reading it had risen to 1·95. A third discharge brought it back to 1·62, and after that it continued to oscillate between these two values for some 20 or 30 times with hardly a break in the regularity. Obviously one spark formed a resistance, and the next blew it away again. The character of the sparks was quite different, too. The one which formed the resistance was thin and sharply defined, and spread out for a considerable distance over the plate like a splash. The other was much brighter, straight, and without any signs of a defined edge.

While, however, the above is evidence of the existence of surface-resistance at used points, the fact that the values of f at beginning and end of discharge are practically identical for a clean point for both positive and negative electricity, may be regarded as showing that such resistance is either very small or non-existent on points which have not been used before.

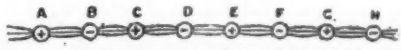
Atomic Charge.

Section 6.—Assuming, then, provisionally that cohesion in Grotthuss chains is the sole cause of the resistance offered to discharge at a clean point, and that gas atoms are consequently concerned in carrying the electricity when it does so,* there arises the interesting question as to the amount of charge carried by each atom; and one is tempted to see whether the above measurements throw any light on it. Without in any way pretending to settle the point, the following considerations seem to me to render it probable that the electro-chemical equivalent of gas atoms is of the same order of magnitude as that of the same atoms in electrolytes.

The essence of a Grotthuss chain is that it shall consist of molecules capable of being split into two parts, one of which is charged after the split with positive electricity and the other with negative. These charges may exist separately in the molecules to start with, or they may be induced by an electrostatic field—but in either case it is the field which subsequently arranges them in chains; and the breaking down of the chains occurs when the mechanical pull of the field on the charged parts is sufficient to overcome their mutual affinity. This affinity may be due to one or two causes or their combinations. Either it is (*a*) the electrical attraction of two initial charges, or it is (*b*) a cohesive attraction without any previously existing charges, or it is (*c*) both. One of these three it must be, if by cohesive attraction is understood the sum of all non-electrical forces between the two parts of the molecule.

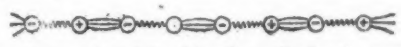
Consider the first (*a*) of these cases. If the molecules hold together by internal charges, they may be represented thus in their free state:

the lines in between the pairs of atoms signifying lines of electrostatic force. A chain of such molecules will give way when it is put in a field of force just strong enough to redistribute the charges by induction, so that half as many lines pass between A and B, C and D, &c., as before, and the remainder pass between B and C, D and E, &c. This state of things may be represented thus:



Put in another way, the strength of the field which will do this is rather greater than that which would induce on each of the two end atoms of the chain half their assumed initial charges, supposing them to be connected by a fine conducting wire. It depends thus on the length of the chain being greater as the chain is shorter.

In the case (*b*), a constant cohesive affinity between the two parts of the molecule, it is necessary to suppose that electricity can pass from one to the other under the influence of induction when they are put in a field of force, in order that after separation they may be oppositely charged. The following figure shows a chain of such



molecules on the point of breaking down, the break occurring when the cohesive forces (~~~~~) are just overcome by the electrical forces (═══) set up by the field. Here, again, the longer the chain the weaker the field required to break it; and as the cohesive forces are constant, and the electrical forces are dependent, for given molecular arrangement, only on the charges induced in the molecules, it follows that these charges will also be practically constant, no matter what the length of the chain may be.

In both these cases, therefore, for all lengths of chain, the atomic charges at the breaking point are constant; in case (*b*) being rather less than such as would be induced by the field on the end atoms, supposing the latter to be connected by a conductor; and in case (*a*) less than twice that amount (less because the chain is not a continuous conductor). Their values might thus be calculated in terms of f if the geometrical conditions were known. This, however, is not the case under the conditions of actual experiment; but by arranging that the chains shall consist of single molecules only, it is possible to get an idea of the magnitude of the charge in question. Reduce in imagination the discharging point to molecular dimensions; and find, by what is rather violent extrapolation, the corresponding value of f at discharge from the constant in Table II. The Grotthuss chains will have been reduced to single molecules by the reduction of the point, and by supposing them to be spheres the + and − charges induced on their opposite sides may be calculated. These charges will then represent in the case of (*a*) half, and in the case of (*b*) the whole of the atomic charge.

Taking the diameter of a molecule $\frac{1}{2} \times 10^{-8}$ centimetres, the value of f at the centre of a molecule opposite the point is (from Table II.)

$$f = \frac{16\cdot5}{4} \times \left(\frac{1}{4}10^{-8}\right)^{-0\cdot8} = 3\cdot1 \times 10^{7} \text{ E.S. units.}$$

which will induce on a conducting sphere of the same dimensions equal and opposite charges of

$$\frac{3}{4}\left(\frac{1}{2}10^{-8}\right)^{2} f = 6 \times 10^{-10} \text{ E.S. units.}$$

This number is greater than the atomic charge (or than half the

* This does not preclude the possibility of metal dust in the discharge after it has once started.

atomic charge) because it is calculated from measurements on chains of many molecules, which, as was pointed out above, are not conductors, but only lines of high S.I.C. Now the most probable value of the ionic charge of oxygen is 10^{-11}, which, considering the extent of the extrapolation and the fact that the above number is too great, is in sufficiently striking agreement with it. It is at any rate satisfactory that the experimental number is the larger of the two.

It is interesting to see whether a similar result is to be got from measurements of sparks between plates. Taking Dr. Liebig's numbers above referred to, I find, following Prof. J. J. Thomson, that the formula $f = \frac{a}{l} + 150$ expresses the results for the smallest spark-lengths in air fairly well, considering that the numbers for that part of the curve are rather irregular. The values of a lie between 1·9 and 1·4 for the five smallest spark-lengths (l = 0·0066 to 0·0245 centimetres. Extrapolating for a distance between the plates of $\frac{1}{2} \times 10^{-8}$, the field between them comes to be 4×10^{-8}. This would induce a still higher charge (8×10^{-9}) on a spherical molecule; but it must be remembered that these data are much further removed from molecular dimensions than mine.

On the other hand, there is a case accessible of what may, perhaps, be called discharge between plates, which takes place actually within molecular dimensions: I mean the passage of electricity at the cathode of a voltameter. Here, if a step of potential of, say, one volt be assumed, and if f stand for the corresponding field between the liquid and the metal of the cathode,

$$f \times \frac{1}{2} 10^{-8} = \frac{1}{300}, \text{ or } f = \frac{2}{3} 10^{6} \text{ E.S. units.}$$

This is capable of inducing on a spherical molecule charges of $1{\cdot}5 \times 10^{-11}$ E.S., a number which cannot be distinguished from the ionic charge. Moreover, no reduction is necessary here as the data of calculation are from measurements made direct on single molecules.

Taking, then, these three calculations together, and having regard to the fact that the nearer the conditions of experiment approach molecular arrangement the closer are the results to the value of the ionic charge, I cannot help thinking that they furnish strong grounds for supposing that electrified atoms in gases are associated with the same quantity of electricity as in electrolysis.

As regards the third possibility of molecular cohesion (c) mentioned above, that it is due to a combination of (a) and (b), it is impossible, without knowing the relative values of the two forces at work, to get any idea of the atomic charge from the value of f. All that can be said is that it will be less than the value calculated for atoms held together by electrical attraction only. Even in this case, therefore, there is nothing to negative the presence of ionic charges in gaseous conduction.

Effect of Pressure.

Section 7.—If the conclusions arrived at above be correct, one may picture a metal point on the verge of discharging as a smooth curved conducting surface studded all over with Grotthuss chains standing up on it like bristles. The density of charge upon it will thus be far from uniform. It will reach a maximum at the root of each chain, the quantity collected there being constant for a given gas, independent of the length of the chain, and equal, perhaps, to the ionic charge of the gas atoms. In between the chains the density will be much less.

Now the field, f, measured by the attraction of a plate on a needle point is the average number of lines of force per square centimetre of the point-surface, and takes no account of the manner in which they are distributed over it. This is because the point is so small that the lines have room to become uniformly spread out before they reach the plate. Hence it follows that, for different dispositions of the chains, the measured values of f may be very different, and yet the number of lines of force running through each chain be the constant number corresponding to ionic charge on its atoms; f, in fact, for a given amount of induction per chain, depends both on the length and on the closeness of the chains. Great length, or great closeness, or both, means that the greater part of the lines proceeding from the point have been absorbed by the chains, hardly any passing in between them. In this case f is practically proportional to the number of chains per square centimetre, and is independent of their lengths. On the other hand, very short chains, or very few to the square centimetre, or both, means that f is sensibly independent of their closeness, but is now dependent on their length, being inversely proportional thereto so long as it is not very great compared with the radius of curvature of the point. In between these two extremes f depends both on length and on closeness of the chains, varying in an inverse manner with the former, and in a direct manner with the latter.

Now, both length and closeness of the chains increase with increase of gas pressure; hence, there must be some pressure, A, above which f is sensibly proportional to the closeness of the chains only, and some lower pressure, B, below which it is inversely proportional to the chain-lengths only. In the neighbourhood of A increase of pressure will affect f chiefly by the resulting alteration of the closeness, and will therefore increase f. Near B it will have the opposite effect, as increase in the length of the chains means a decrease of f. Hence between A and B there must be some pressure for which f is a minimum. This point is, of course, well known to exist,* though I was unable to obtain a sufficiently good vacuum with my apparatus to reach it. If, however, f be expressed in terms of some power (n) of the pressure, n will be 0 at the minimum point, and positive and increasing as the pressure rises from there. This increase is shown well in Table III. (calculated from Table II. for positive discharge only—the negative is too uncertain). Here n_1 is calculated from the values of f, corresponding to 76 and 40 centimetres of mercury, and n_2, for 40 and 20 centimetres; n_2 is in every case less than n_1.

* Röntgen, Weidemann's Electricität, vol. iv., section 582.

TABLE III.

Needle.		r.		n_1.		n_2.
C	...	$0{\cdot}7 \times 10^{-8}$	...	0·31	...	0·20
D	...	1·6 "	...	0·42	...	0·36
E	...	1·88 "	...	0·39	...	0·34
F	...	4·03 "	...	0·48	...	0·35
G	...	4·84 "	...	0·48	...	0·44
H	...	6·52 "	...	0·50	...	0·39
I	...	7·11 "	...	0·53	...	0·42
J	...	7·83 "	...	0·49	...	0·38
K	...	8·71 "	...	0·52	...	0·40
L	...	10·9 "	...	0·52	...	0·46
M	...	31·8 "	...	0·61	...	0·58
N	...	45·7 "	...	0·69	...	0·61
O	...	58·0 "	...	0·69	...	0·56
X	...	400·0 "	...	[0·80]	...	0·72

The needle marked X was in reality a steel ball used for bicycle bearings. This was put opposite a tin disc of 6 centimetres diameter at a distance of 3·6 centimetres. n was calculated from measurements of the difference of potential between ball and plate, as f could not be measured. The values of n fit in well with the rest. (n_1 was calculated in this case from f at 40 and 60 centimetres mercury.)

Now pressure alters the length and closeness of the chains at the same time; but for a given field strength at a point-surface, alteration in curvature gives rise to alteration of chain-length only, the length being less as the point gets sharper. Hence at a sharp point f is more dependent on the length of the chains than at a blunt one; it is, in fact, nearer its minimum value, and n is consequently less. This, too, is shown very clearly in Table III.

A pretty illustration of the influence of point curvature on n was accidentally met with in the case of needle C. In getting it into the apparatus for repetition of the curves obtained with it, its point came against the metal box, and was flattened slightly to a width of about $3{\cdot}6 \times 10^{-3}$ centimetres. The value of n_1 and n_2 obtained from it after this were respectively 0·42 and 0·30, instead of 0·31 and 0·2 for the finer point.

Grotthuss chains, coupled with constant atomic charge, are thus well able to explain most of the phenomena described in this paper. There still remains one which is perhaps the most important of all—the difference in the behaviour of positive and negative discharge. This I hope to discuss in connection with experiments now in progress, but it may perhaps be well to place on record the results so far obtained.

TABLE IV.

	—		r.		k.
C	... ...	$0{\cdot}7 \times 10^{-3}$	... ...		1·36
D	... ...	1·6 "	... ...		1·42
F	... ...	4·03 "	... ...		1·40
G	... ...	4·84 "	... ...		1·26
H	... ...	6·52 "	... ...		1·28
I	... ...	7·11 "	... ...		1·23
J	... ...	7·83 "	... ...		1·24
K	... ...	8·71 "	... ...		1·32
L	... ...	10·9 "	... ...		1·13
M	... ...	31·8 "	... ...		1·08
N	... ...	45·7 "	... ...		0·94
O	... ...	58·0 "	... ...		0·94
X	... ...	400·0 "	... ...		0·83

These are given in Table IV., where k is the ratio at a pressure of 20 centimetres of f for positive discharge to f for the negative. The ratio shows a distinct tendency to decrease as r increases. It is almost useless to give values at higher pressures on account of the uncertainty as to the condition of the point, and the great effect this may have on the negative discharge (curves III.); but the ratio is distinctly less at higher pressures, for points which seemed quite clean; the decrease of k at 70 centimetres mercury varying from 3 to 8 per cent. as compared with k at 20 centimetres. For dirty points the decrease may reach 50 per cent.

Description of Apparatus.

Section 8.—The electrometer used for potential measurements was constructed on the principle of the one designed some years ago for absolute measurement of much smaller quantities by Prof. Minchin. The attracted disc is suspended, and the force of attraction measured by tilting the whole instrument until the disc falls back by its weight to a fixed point. The disc is a sheet of mica, covered on one side with tinfoil and metallically connected with the case of the instrument, which is a tin cylindrical box 30 centimetres long by 30 centimetres diameter. The disc hangs just outside a 3 inch hole in a tin screen at one end of the case, and opposite the hole inside the case is an adjustable disc of tin which forms the attracting plate. The sensitiveness of the instrument may be varied very greatly by altering the distance between this plate and the suspended disc. This arrangement does not of course permit of absolute measurement, but it was thought that calibration in terms of spark-lengths was sufficiently accurate for the work in hand.

The same principle of tilting was used in measuring the attractions on the needle-points; the needle in this case taking the place of the suspended disc. The zero position was determined by a hair in the eye-piece of a microscope through which the point of the needle was observed; the latter being at the centre of curvature of C D, fig. 1, when it coincided with the hair. The needle was illuminated by small windows in T (not shown). L was connected to the Wimshurst; T to earth; and G—*i.e.*, N—through a high resistance galvanometer to earth, the indications of the galvanometer being therefore due only to current discharged from N. A much larger instrument, constructed on the same lines, was used for needle A and other measurements. The body of this instrument is a a tin cylinder, 43 centi

metres long (horizontally) and 23 centimetres in diameter. The needle is suspended in a small metal box at the centre, and the electrified plate is supported like C D, fig. 1, from one end.

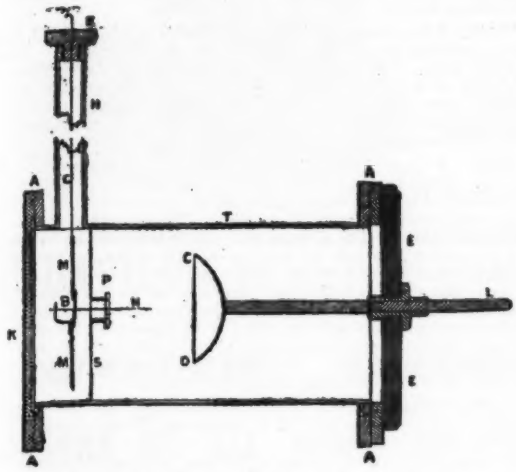


FIG. 1.—T, brass tube forming body of instrument; length 10 centimetres, diameter 6 centimetres.
H, tube for suspension wire, G. F, ebonite plug.
M, mica disc suspended from G, carrying light metal clip B, holding needle N.
S, tin screen soldered into T.
K, metal cover. E, ebonite cover.
A A, ground air-tight joints, greased.
C D, spherical metal cup to be electrified; C D = 3·35 centimetres, radius of curvature = 1·76 centimetre.
P, short brass tube on S; length = 0·5 centimetre, diameter = 1·2 centimetre.
Point of N at centre of curvature of C D. Length of needle projecting beyond P = 2 centimetres.

The tilting is effected in each of the above instruments by fixing them to a brass base, provided with pivots at one end and a vertical micrometer-screw with large divided head at the other. The method works admirably.

In conclusion, I wish to express my thanks to my friend Mr. F. B. Fawcett, a former student of University College, Bristol, and to my assistant Mr. J. Quick, for much careful help in carrying out the measurements described in this paper. To Prof. Lodge my thanks are so numerous that I cannot express them. His kindness, both by word and by deed, has been unceasing. Indeed, but for him, this paper would probably never have been written.

Results.

1. Point-discharge depends only on the strength of field close to the point between pressures of 76 and 10 centimetres.
2. Field here measured absolutely by its pull on the point.
3. Seat of resistance to discharge shown to be in gas only, for a clean point (Grotthuss chain).
4. Atomic charge, probably of same order of magnitude as ionic charge.
5. Effects of pressure and of point-surface curvature in accordance with Grotthuss chains.

DISCUSSION.

Mr. SEARLE said he was anxious to show the discharge from points to some people recently, and he devised a small instrument for getting a rough estimate of the actual mechanical force exerted at the point when discharge took place. He had a metal rod about 20 centimetres long, and at the end he fixed two points at right angles. The rod was suspended by a thin metal wire. He then electrified it, and the discharge threw the wire down. Knowing the length, &c., it was easy to calculate the actual mechanical force acting on the point of the pin. In one case, when a Wimshurst machine was discharging and giving a spark of one inch, this force was as much as ·2 grammes. He was very much surprised to find how large it was. He hoped Mr. Chattock would make some experiments in this direction also.

Prof. LODGE (President), referring to Mr. Chattock's diagram showing the condition of the molecules when charged electrically and when not, called attention to Mr. Crookes's experiments on the evaporation of metals, that was to say the way in which metals were thrown off when the discharge took place from them. It was as if a skin was taken off. Mr. Crookes found great differences according to the kind of metal. Gold seemed to be most easily evaporated, but two were not thrown off at all—aluminium and magnesium. He would ask Mr. Chattock whether he had ever tried points of these metals in order to obtain air undisturbed by the presence of metallic dust thrown off by the discharge.

Mr. CHATTOCK, in replying, said he was glad to find Mr. Searle had found that there was a large force acting on the point. He was trying to separate the two effects, the one acting upon the discharging end of the needle, and the field of force acting upon the other end. He did not think that could affect matters as far as those data went.

The PRESIDENT congratulated Mr. Chattock on the results of his research, and thought the paper a most valuable one.

DISCUSSION ON REPORT OF ELECTRIC STANDARDS COMMITTEE.

Prof. VIRIAMU JONES said he had sometimes seen it stated that it would be of great use to those engaged in practical electrical engineering operations to have accurate small standards of resistance. This seemed to be a direction in which the committee had not so far worked. He referred to a reliable resistance of $\frac{1}{1000}$th of an ohm. They were able in Cardiff to construct standards of two-thousandths of an ohm in absolute measure. The accuracy upon which they could rely would be something between 1 in 5,000 or 1 in 10,000. He would be glad of an expression of opinion as to whether such standards of resistance would be useful in practice. The way in which they might be employed would be the measurement of large currents.

Mr. BLAKESLEY asked if the committee dealt with the alteration which took place in standard condensers?

Prof. CAREY FOSTER said that was one matter which the committee had attended to, and experiments were now being made with air condensers. Not much work had been done as yet. However, the air condensers were not constructed with the hope of their being absolute standards, but simply with the view of their being permanent, and avoiding residual charge.

Mr. PREECE would like to answer Prof. Jones by saying that a demand was really arising for apparatus that would measure currents of very great intensity. The use of electricity for the deposition of copper and for the manufacture of phosphorus was growing fast, and currents were employed up to 4,000 ampères. He was afraid that none of their manufacturers were in a position at present to supply them with ampèremeters which would measure a current of 3,000 ampères with anything like the reliability they could get by means of small resistances, such as Prof. Jones proposed to make. These would enable them to measure with great accuracy.

A MEMBER said that the Germans had taken up this question of small standards of resistance, for which there was a great demand in that country. They issued standards for $\frac{1}{1000}$th of an ohm, and he believed still smaller ones.

Prof. LODGE remarked that Prof. Jones had said he could issue these standards if the engineers wanted them. If they really were wanted no doubt the committee would consider the matter, and possibly take it in hand.

LEGAL.

Savory & Moore v. The London Electric Supply Corporation, Limited.

IN this action, Mr. Justice Kekewich sitting in the Chancery division of the High Court of Justice, on Friday in last week, gave judgment on a motion for an injunction by the plaintiffs, a well known house of chemists in New Bond Street, to restrain the defendants from causing a nuisance or annoyance to them in their business by the use for generating or distributing electricity of premises adjoining those of the plaintiffs. The defendants took the premises, whose use was complained of, in 1887, and with the cellars of the adjoining Grosvenor Gallery, fitted them up with engines, boilers, and other machinery, in connection with their supply of electricity. Consequent on plaintiff's remonstrances on account of the annoyance to which they were subjected from noise and concussion, and their apprehensions resulting from their store-rooms for chemicals being in immediate proximity to defendant's works, defendants in 1890 ceased the generation of electricity there, but made it a converting and distributing station of the current received from their Deptford generating station. In October and November of 1890 fires broke out on defendant's premises, and by the second of these considerable damage was done both to them and in a lesser degree to plaintiffs by dirt, water and smoke, beside confirming the latter's fears as to the danger of such works close to their stores of chemicals. They accordingly commenced their action, and the subject came before his lordship in the spring of the present year, but was adjourned to see if arrangements could be made to satisfy plaintiffs and allay their apprehensions. These negotiations, however, had ended in nothing satisfactory being arrived at, defendants denying the risks of fire feared by plaintiffs, and relying upon the precautions against possible accidents which they had taken and were making, with the sanction of the Board of Trade; they added that the combustible and inflammable materials stored by plaintiffs themselves constituted the real danger and involved their (defendants') premises.

HIS LORDSHIP having patiently heard the evidence, including that of the manager of the company, took an evening to consider his judgment, and in the result said it was not disputed that there was now no imminent danger; but with the uncertain knowledge as yet possessed, even by scientific men, as to the powers and dangers of electricity in the heart of a crowded city, it was not so clear, even when defendants' arrangements were perfected, that the plaintiff's apprehensions were groundless. In view of what occurred in November, 1890, he could not say the plaintiffs were unreasonable in asking for an undertaking in the terms of the writ; nor had it yet been shown what parts of defendants' premises were to be used, or that the elements of danger from fire had been or would be completely removed. In these circumstances he held plaintiffs entitled to an injunction in the terms which they had expressed a willingness to accept, and that injunction he granted, with costs against the defendants.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

15,110. "Improvements in the distribution of electricity." T. PARKER, H. WOODWARD, and E. S. G. REES. Dated October 10th. 8d. The motor-generators at the sub-stations are supplied with high tension currents from the switch stations and the circuits from the switch stations to the sub-stations, and the switches for controlling these circuits are so arranged that when not more than a certain fraction (depending upon circumstances) of the maximum current supplied from any sub-station is being used, the motor-generator at that station is stopped, the lamps or motors then in use being then supplied from the switch station direct at a suitable electromotive force through the same leads as those used for supplying the high tension current to the motor generators when more than the fraction of load determined is being used. 4 claims.

15,252. "An improved holder for incandescent electric lamps." H. SOUTH. Dated September 26th. 8d. Claims:—1. An improved holder for incandescent electric or glow lamps, comprising a circumferential contact nut secured upon a base or support and prevented from turning thereon, a central contact mounted on the said base and within the said nut, and an enclosing cover of non-conducting material secured upon the said base and having an opening therein to admit the neck of a lamp to the contact nut, substantially as and for the purpose described. 2. An improved holder for incandescent electric or glow lamps, comprising a circumferential contact nut secured upon a base or support and prevented from turning thereon, a central contact mounted on the said base and within the said nut, and an enclosing cover of non-conducting material, engaging with a screwed flange upon the said contact nut, substantially as and for the purpose described. 3. The combination of a base or support adapted to receive electrical connections on one side and one or more holders for electric glow lamps on the other, substantially as and for the purpose shown and described.

16,196. "Improvements in incandescent electric lamps." W. R. LAKE. (Communicated from abroad by J. B. Tibbits, of New York.) Dated September 9th. 8d. Consists in supporting a straight filament in metallic carrying arms, and sealing the same within a glass globe, the said arms being separated at their upper ends by a block of non-conducting material, and the whole being so arranged that if the filament breaks, the said arms automatically engage or come in contact with each other, thereby forming a closed circuit and thus effectually "cutting out" the filament from the circuit. 5 claims.

16,223. "Improvements in the parts of electric meters connecting the movements of the solenoid with the calculating train." H. BURROW. Dated October 11th. 8d. For the complicated mechanism of these parts of electric meters the inventor substitutes a metal stud firmly attached to the solenoid, and at the top of the stud he fixes by a hinge, pivot, or spring joint, one or more metal traversing rods, to the under edge of which he attaches a strip of leather, India-rubber, or any other suitable material. This end of the traversing rod falls by gravitation, or is pressed by a spring directly on to a ratchet wheel, or wheels, made of steel, iron, brass, or any other suitable metal, which wheel, or wheels, is, or are, placed on a spindle of the calculating train. 2 claims.

16,347. "Improvements in electric clutches." P. W. WILLANS. Dated October 14th. 6d. In order to connect two shafts in line with each other, one the driving and the other the driven shaft, the inventor fixes upon the one an iron cross head or magnet core with projecting extremities and upon the other an iron wheel or ring. There are internal projections upon the ring on either side, and the arrangement is such that the extremities of the first-mentioned part come into close proximity to the projection on the interior of the ring. One of the parts is wound with coils through which an electric current may be passed; in this way one part is magnetised and the other part completes the magnetic circuit. In this clutch the parts do not come into actual contact, but operate by the magnetic drag. 2 claims.

16,399. "Improvements in or relating to the electro-deposition of metals." A. J. BOULT. (A communication from L. A. J. Joray, of Paris.) Dated October 15th. 8d. Consists in submitting the articles under treatment to friction obtained either by the mutual contact of the pieces themselves which it is desired to polish and which are set in motion for the purpose; or by placing such pieces in contact with other bodies specially provided therefor and immersed in the electrolytic bath. 6 claims.

16,556. "Improvements in devices for holding the receivers of telephone instruments or the like." W. P. THOMPSON. (A communication from abroad by J. T. Moore, of America.) Dated October 18th. 8d. A plate or suitable support is provided, which is secured upon the telephone box preferably by a clamp that passes around the box and through the plate, and has nuts upon its ends, thereby securely holding the plate upon the telephone box. An arm is pivoted upon this plate so as to swing in a vertical plane, and the edge of the plate is preferably of quadrant shape, and is provided with a series of notches or teeth. A spring bolt is arranged upon the swinging arms, and is adapted to engage any one of the notches and hold the arm in any desired position. The outer end of the arm is provided with a spring clasp that holds the receiver. 6 claims.

16,963. "Improved means of placing conductors for electricity underground." W. HARTNELL. Dated October 24th. 8d. The inventor places the conductors in pipes, preferably in earthenware or stoneware. These pipes may be jointed to each other by flanges or sockets in the ordinary way. He supports these conductors by bridges of highly insulating material such as glass or porcelain. These bridges are fixed to certain pipes called bridge pipes, or placed between the flanges or sockets of adjacent pipes or placed in the draw boxes. These bridges are by preference so shaped as to offer slight impediment to drawing through or over them one or more suitable conductors.

17,108. "Improvements in dynamo-electric machines." G. PITT. (Communicated from abroad by R. Thury, of Geneva.) Dated October 25th. 8d. Claim:—The employment in dynamo-electric machines of a compensating circuit, annulling the reaction of the armature upon the field in the form of a second armature similar to the first in the same entrefer, and traversed by a current equal to that in the first armature, substantially as described.

17,322. "Improvements in telephones." E. HARTMANN and W. BRAUN. Dated October 29th. 8d. An annular magnet is arranged at the back of the diaphragm, and parallel thereto in a flat circular box or case of metal or suitable materials. This magnet is constructed with a thin plate or disc of sheet steel highly tempered or hardened, and provided with a hole in the centre. The poles are formed by plates attached at opposite sides of the annular magnet, and provided at their inner ends with iron pins perpendicular to the plates, upon which pins the conductor is wound in the form of coils of fine wire, or the plates may be simply provided with three pins, for example, having a bobbin of small dimensions placed on each pin to carry the conductor or coils of wire. This arrangement has the advantage of utilising the wire to the best advantage. 3 claims.

17,486. "Improvements in the construction of magnetic separators." C. W. ATKINSON and L. B. ATKINSON. Dated October 31st. 8d. Consists in the construction of a drum of cast or wrought iron, or other suitable magnetic material forming the magnetic connecting yokes for a series of poles internally placed, surrounded by coils of insulated wire for the purpose of magnetising them. 4 claims.

17,611. "Improved electrical push-button for signalling circuits." C. D. ABEL. (Communicated from abroad by H. Messing, of Germany.) Dated November 3rd. 6d. Claim:—An electrical push-button, having its cap held in position by a caoutchouc ring occupying a groove of the base, and overlapping an inwardly projecting lip of the cap, substantially as described.

17,631. "Improvements in or relating to electric accumulators." P. LAUBER. Dated November 3rd. 8d. The electrodes are made of metallic plates which are impenetrable for fluids. On their surfaces they have deepenings or cavities of any shape, into which the active material is put. The electrolyte is shut in between the electrodes in such a manner that the electrolyte on one side of the electrode has no contact with the electrolyte on the other side. 4 claims.

17,940. "Improvement in arc lamps." SIEMENS BROS. AND CO., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated November 7th. 8d. Consists in arranging two or more pairs of carbons in an arc lamp in such a manner that the same current has to pass through them in series. Between each pair of carbons an arc is formed, and as a certain potential difference is required for each arc, the total potential difference of the lamp can be increased as may be desired, by increasing the number of pairs of carbons. 2 claims.

17,941. "Improved means for charging accumulator batteries on electric circuits supplied by current generators." SIEMENS BROTHERS AND COMPANY, LIMITED. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated November 7th. 8d. Relates to the use of an arrangement of auxiliary dynamo for varying the potential difference between two charging and discharging leads in such manner that a uniform supply to glow lamps, and other current-consuming devices, and a uniform charging and discharging of an accumulator battery, is rendered possible. 3 claims.

18,791. "Improvements in fixings for exposed telegraph wires to insulators." O. IMRAY. (Communicated from abroad by Dr. J. N. Baptista, of Brazil.) Dated November 20th. 6d. Relates to fixings of exposed telegraph wires to insulators by clamps, so as to prevent them from being moved in the direction of their length. 2 claims.

18,896. "Improvements in the process and apparatus for manufacturing copper tubes, sheets, strips, and wires by electrolysis." A. S. ELMORE. Dated November 21st. 8d. Claims:—1. The described process for manufacturing copper tubes by electrolysis, that is to say, preparing mandrils by treatment in baths of cyanide of copper, mounting these mandrils in electrolytic baths charged with acidulated solution of sulphate of copper, and having granulated copper and copper plates arranged as anodes, and the mandrils as cathodes connected to a source of electricity, causing the mandrils to revolve while burnishing tools travel to and fro along their surfaces, and, finally, when the deposit is of the desired thickness, removing the mandrils and their coatings from the baths, and subjecting them to the pressure of rollers travelling along their length, so as to loosen and release the deposited tubes. 2. In applying the process above referred to for electrolytically depositing successive layers of copper on the mandrils above referred to, treating each deposited layer with varnish or oxidation, so as to prevent adhesion of the next layer, substantially as described. 3. For driving the mandrils in a number of electrolytic baths arranged in two parallel rows, the combination of a central shaft, pulleys, and chain gearing to the mandrils, substantially as described. 4. For effecting the to and fro traverse of the burnishing tools for a number of electrolytic baths arranged in two parallel rows, the combination of a screw spindle, clutch, reversing pulleys, tumbling lever, rod and its collars, cross head, its arm, a rod and cross heads and arms, substantially as described. 5. For loosening the tubes of deposited metal from the mandrils, the roller machine substantially as described.

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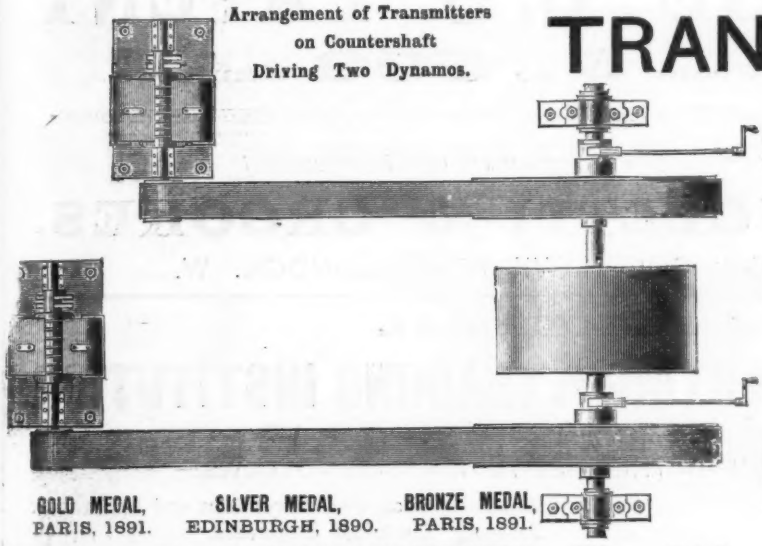

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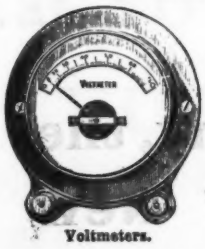

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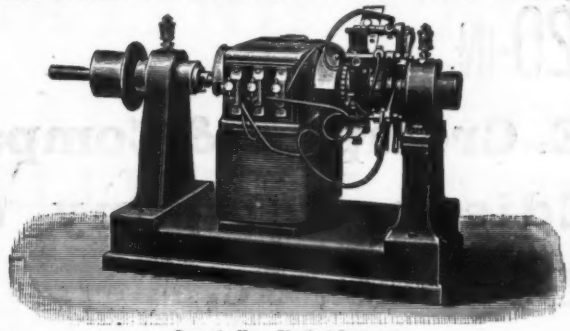

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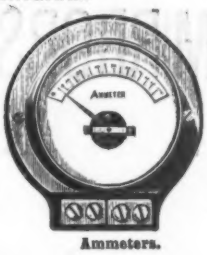

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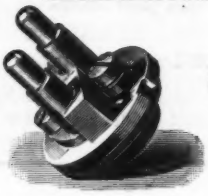
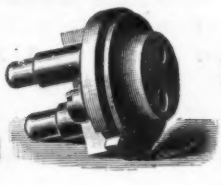
SPECIAL   LICENSE

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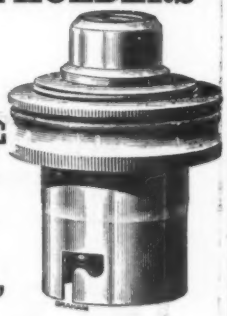

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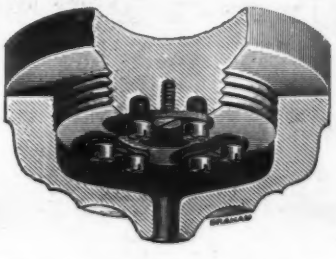

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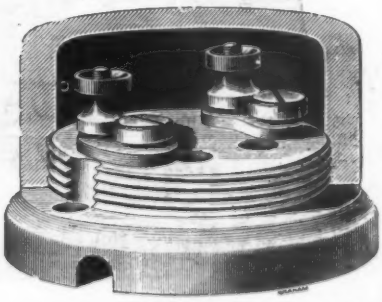

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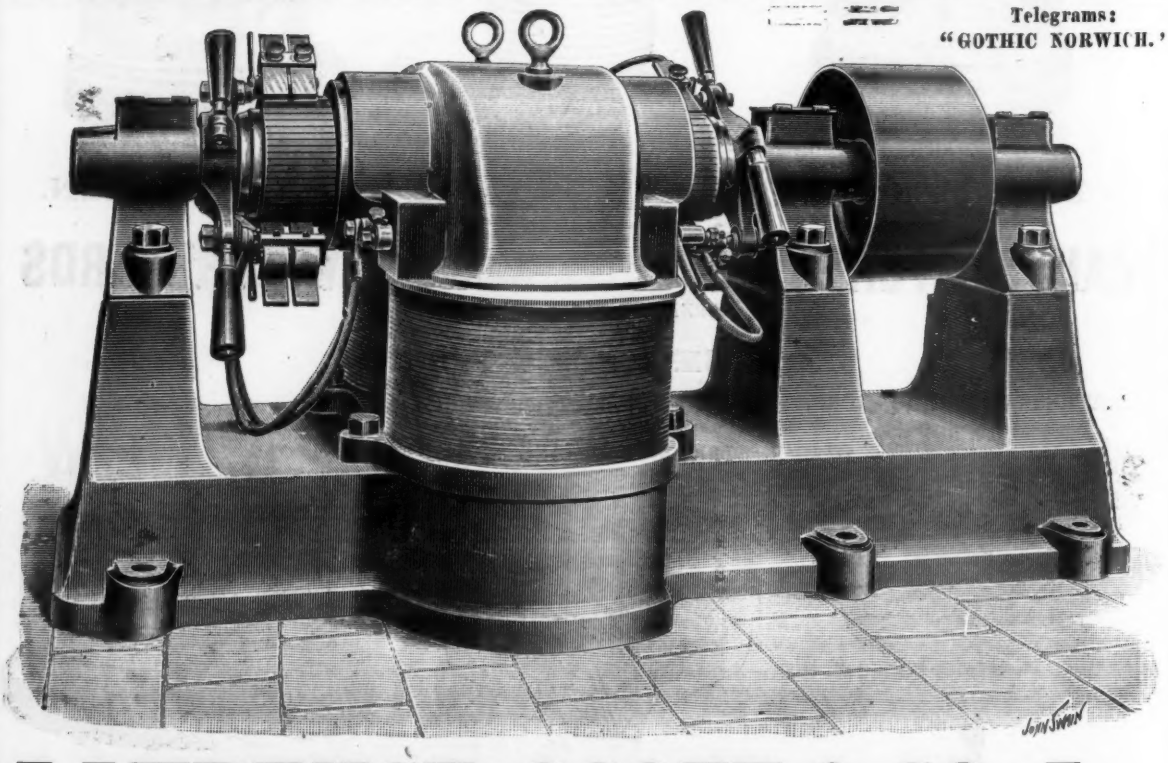

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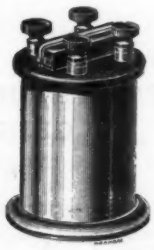

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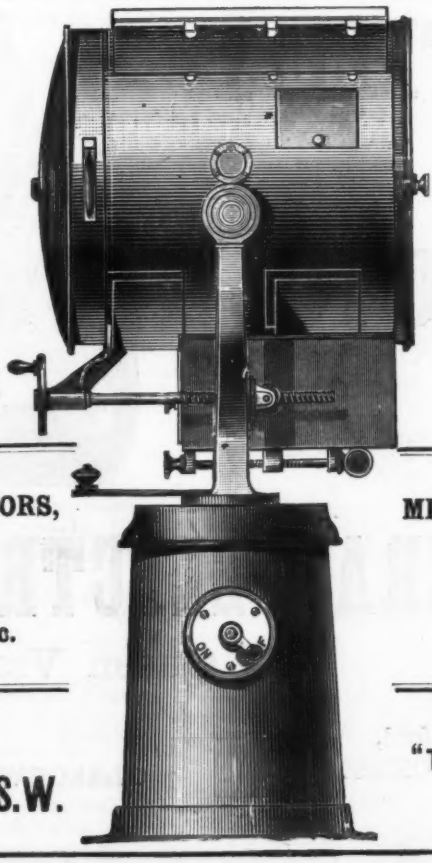

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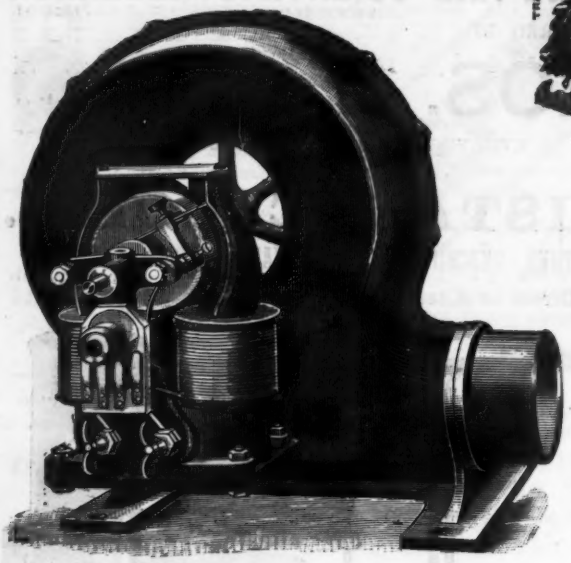

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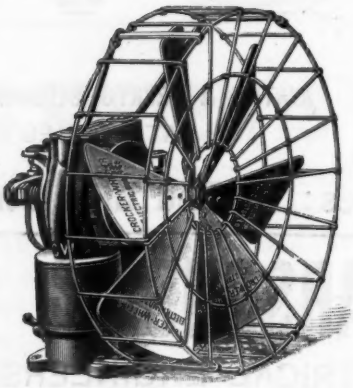

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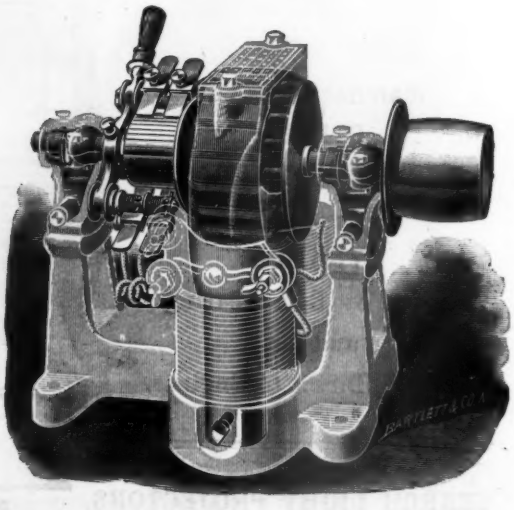

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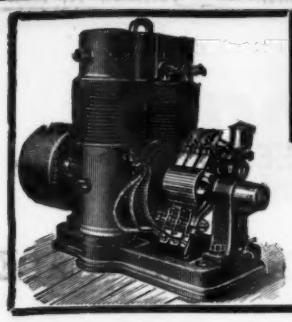

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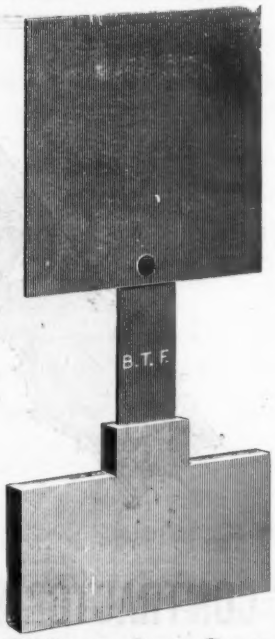

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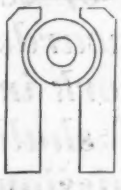

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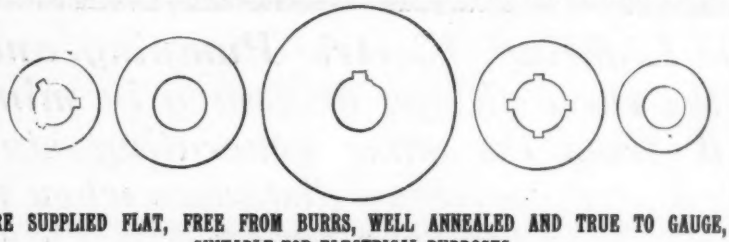

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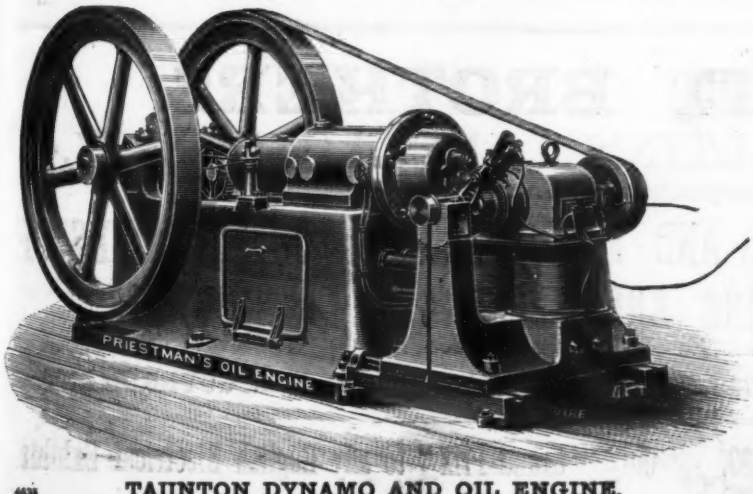

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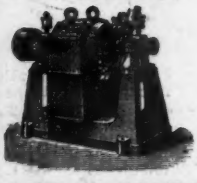

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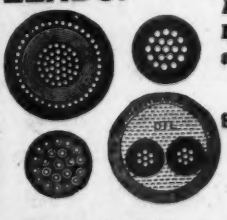

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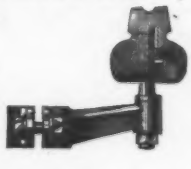

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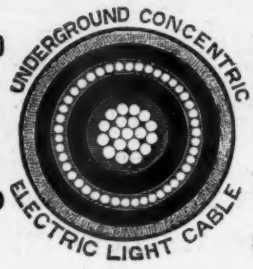

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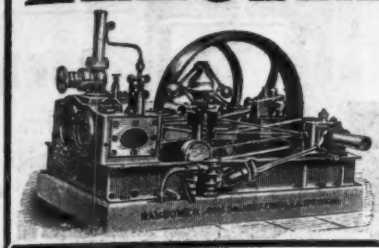

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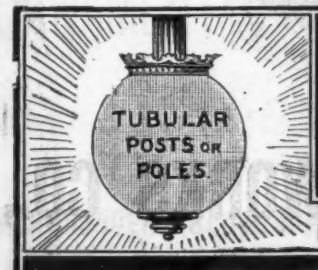

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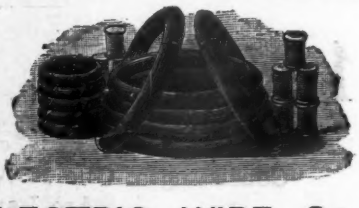

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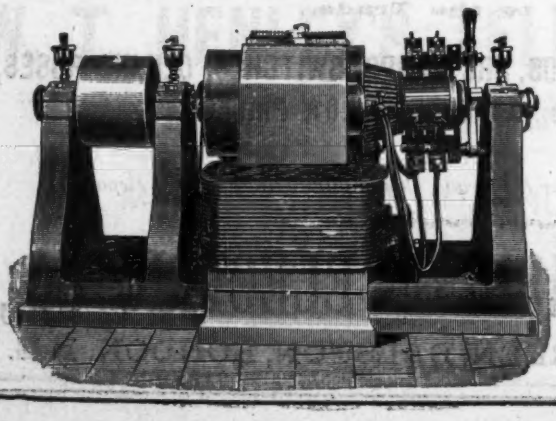

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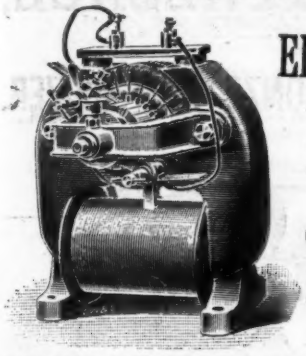

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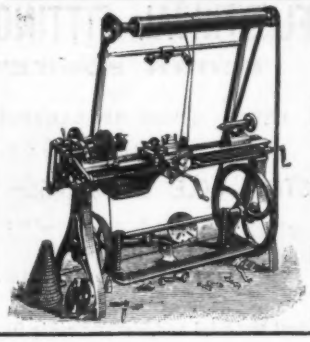

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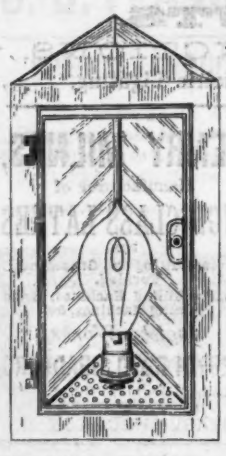

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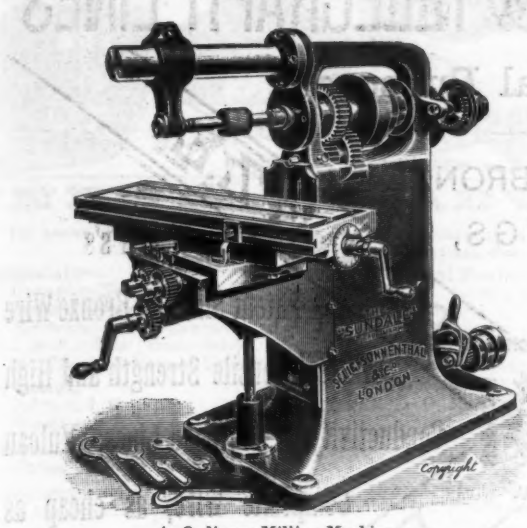

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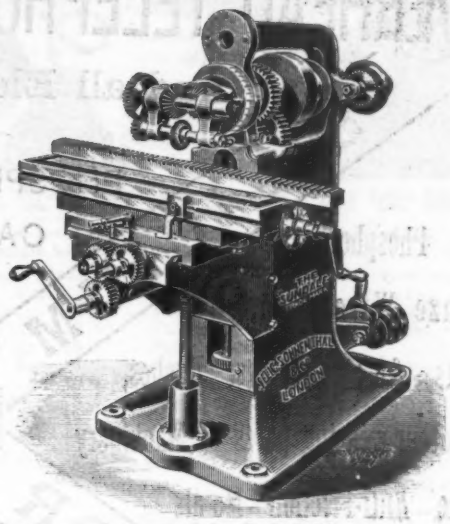

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This Machine has Automatic Vertical, Horizontal and Transverse Feeds. All Feeds are reversible without changing the belt, and can be operated simultaneously or separately. The table can be swivelled to various angles. **With the Vertical and Angular Milling Attachment, the Machine can also be used for Boring, Drilling, Facing, Keyseating Shafts, Rack Cutting, &c.**

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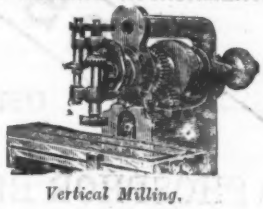

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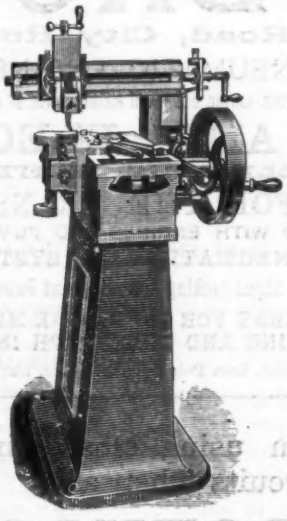

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Illustration represents smallest size.

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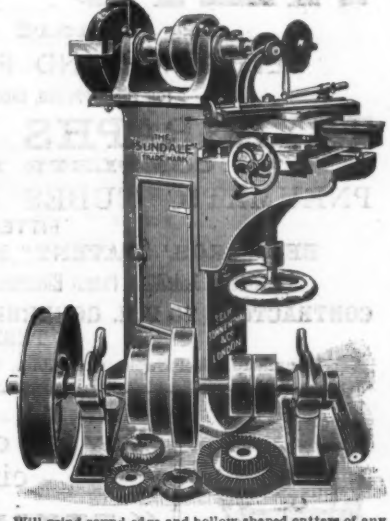

Will grind round edge and hollow-shaped cutters of any radius, angular and bevel cutters of any angle, V-shaped and spiral cutters, cutters which are cut on sides and top, parallel or taper reamers and taps, can be re-sharpened without reducing the diameter.

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400	16	40	0	0
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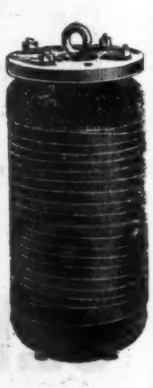
750	30	64	0	0
1000	40	82	0	0

Above 400 lights not stocked.



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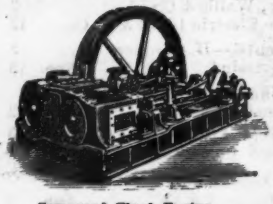

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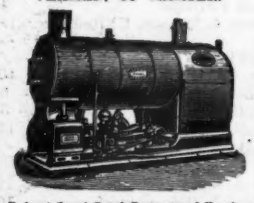

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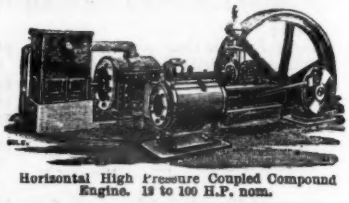

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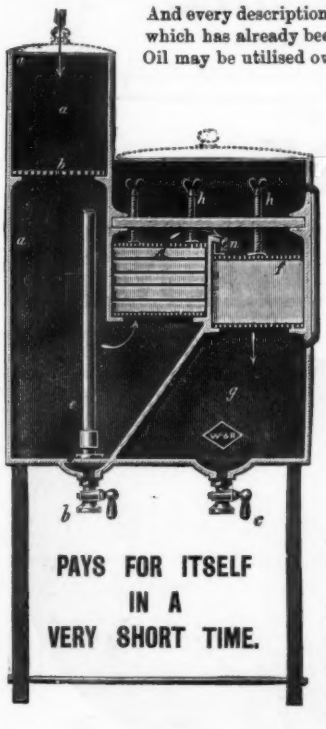

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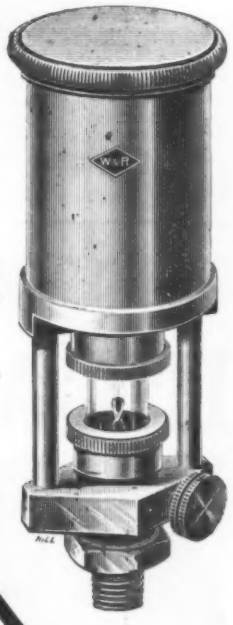

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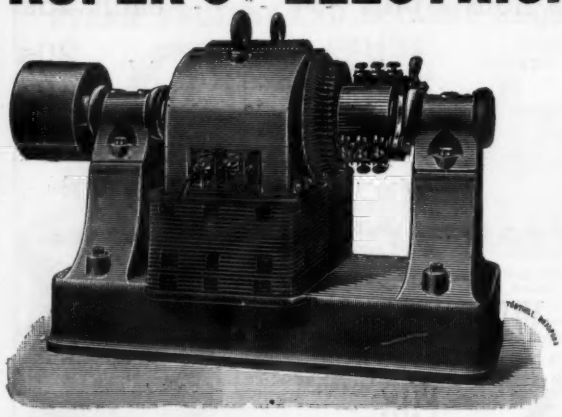

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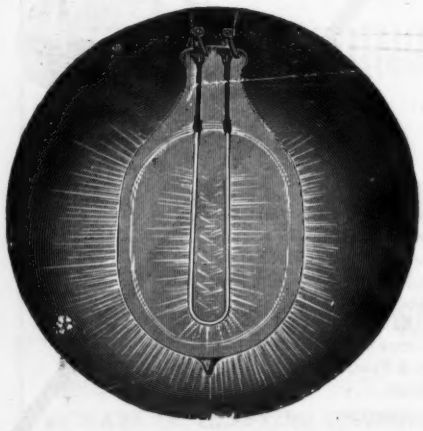

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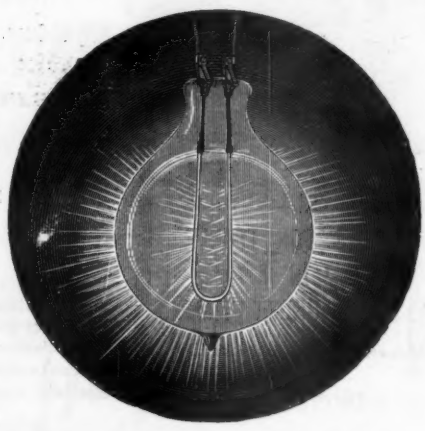

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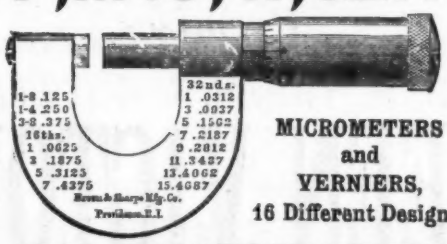

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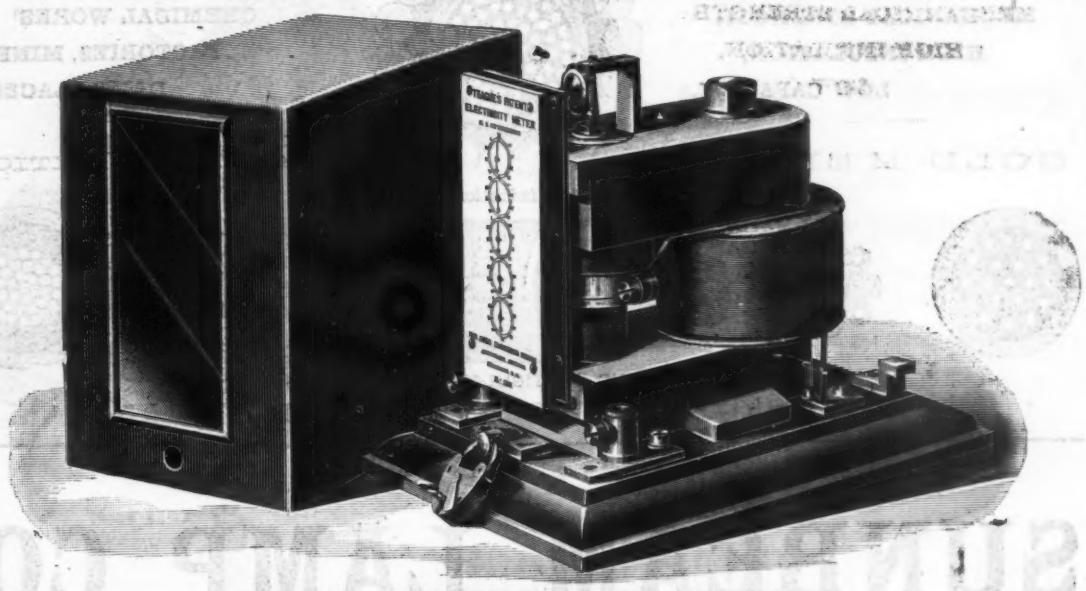

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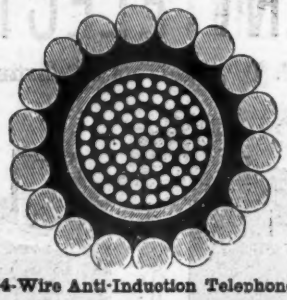

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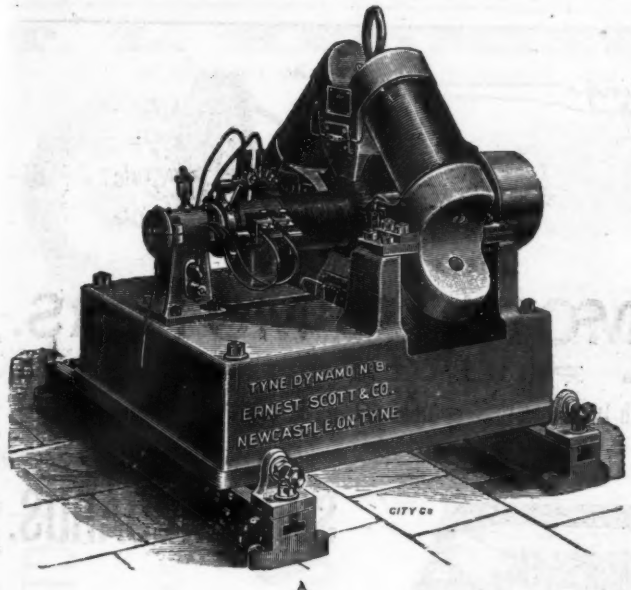

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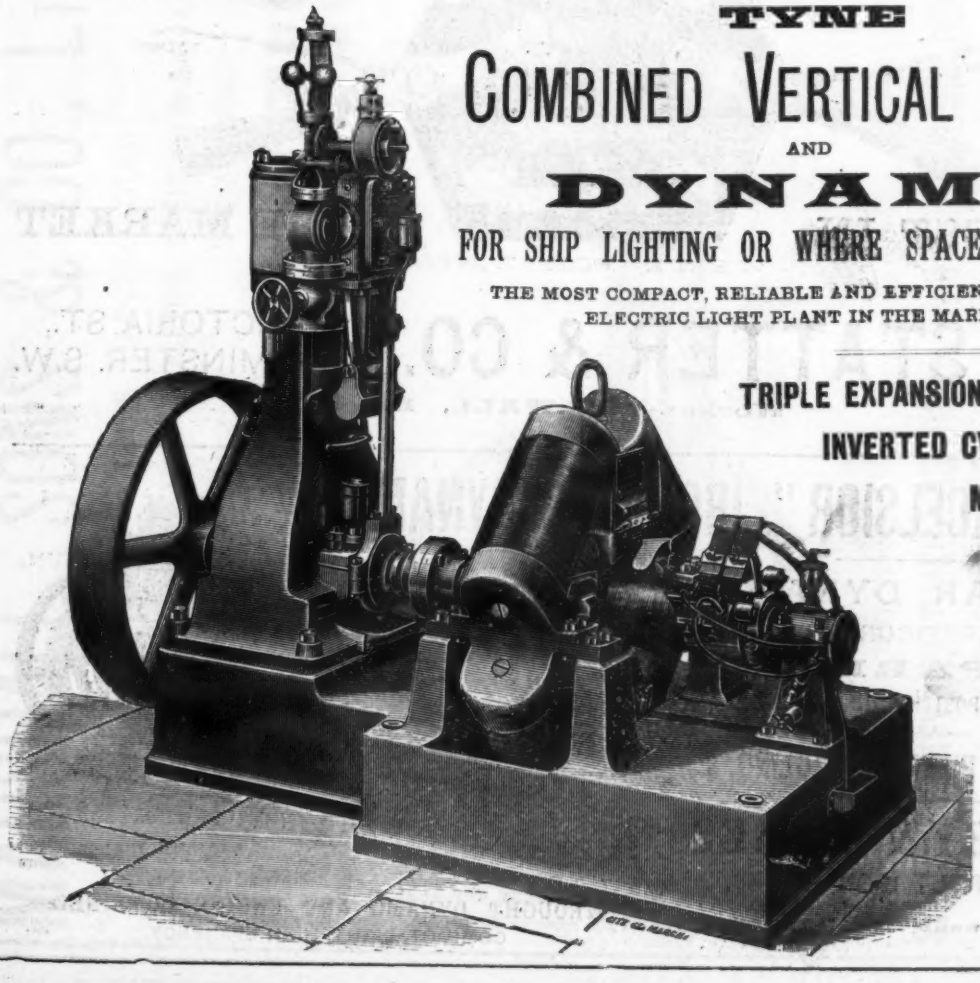

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FOR SHIP LIGHTING OR WHERE SPACE IS LIMITED.

THE MOST COMPACT, RELIABLE AND EFFICIENT COMBINED ELECTRIC LIGHT PLANT IN THE MARKET.

TRIPLE EXPANSION INVERTED CYLINDER MILL ENGINES.

Great economy in consumption of coal.

Brass Castings and Finished Brass Work of all Descriptions.

4160

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ESTIMATES FREE ON APPLICATION. 4188

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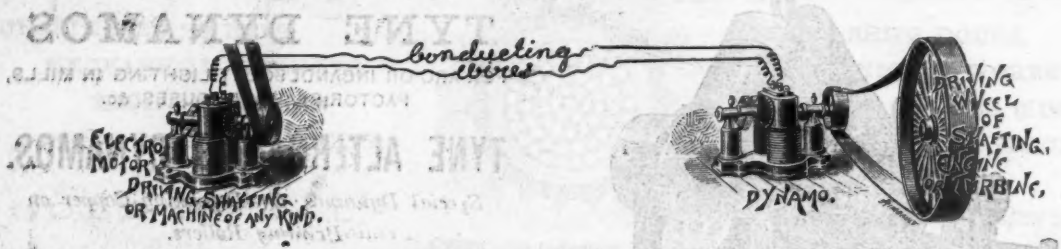
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ELECTRO MOTOR DRIVING SHAFTING OR MACHINE OF ANY KIND.
DRIVING WHEEL OF SHAFTING, ENGINE OR TURBINE.
DYNAMO.

STATTER DYNAMOS AND MOTORS.

FOR ALL PURPOSES.

They never break down! Very High Insulation! Great Solidity in Construction

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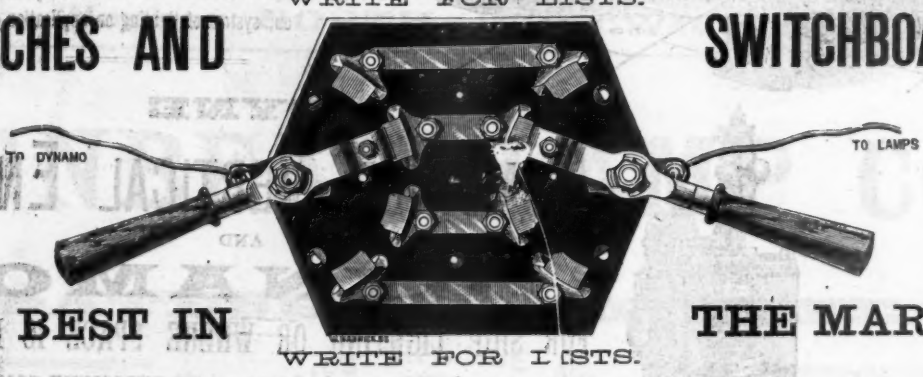

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NO SPARKING.

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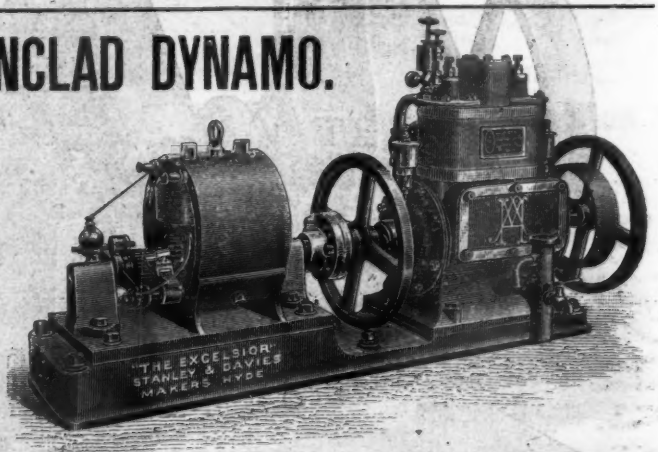

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4176

BELL PRESSES CEILING ROSES,
SWITCHES FUSES.
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Earthenware Appliances for Electric Lighting.

4673

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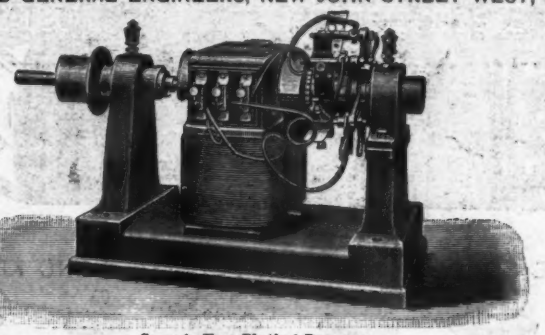

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Illustrated Price Lists on application.

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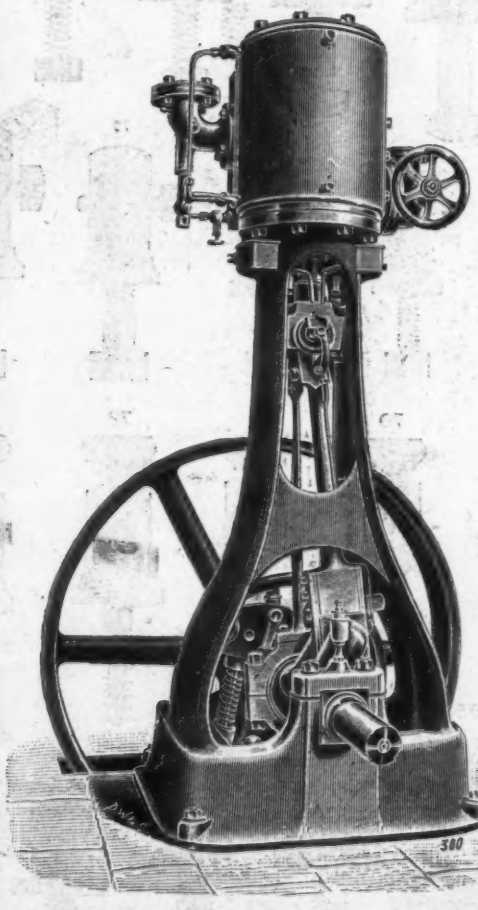

Improved High Speed Vertical Engine with Moore's Patent Crankshaft Governor and Balanced Slide Valve.

ENGINES SPECIALLY ADAPTED FOR ELECTRIC LIGHT INSTALLATIONS,

AND FOR ANY WORK WHERE PERFECT UNIFORMITY IN SPEED IS NECESSARY.

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LOCO-MULTITUBULAR, VERTICAL, CORNISH & LANCASHIRE BOILERS

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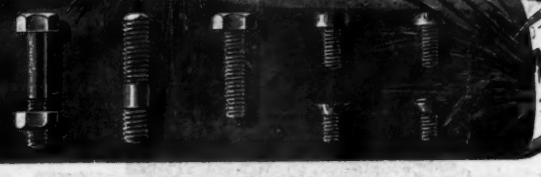
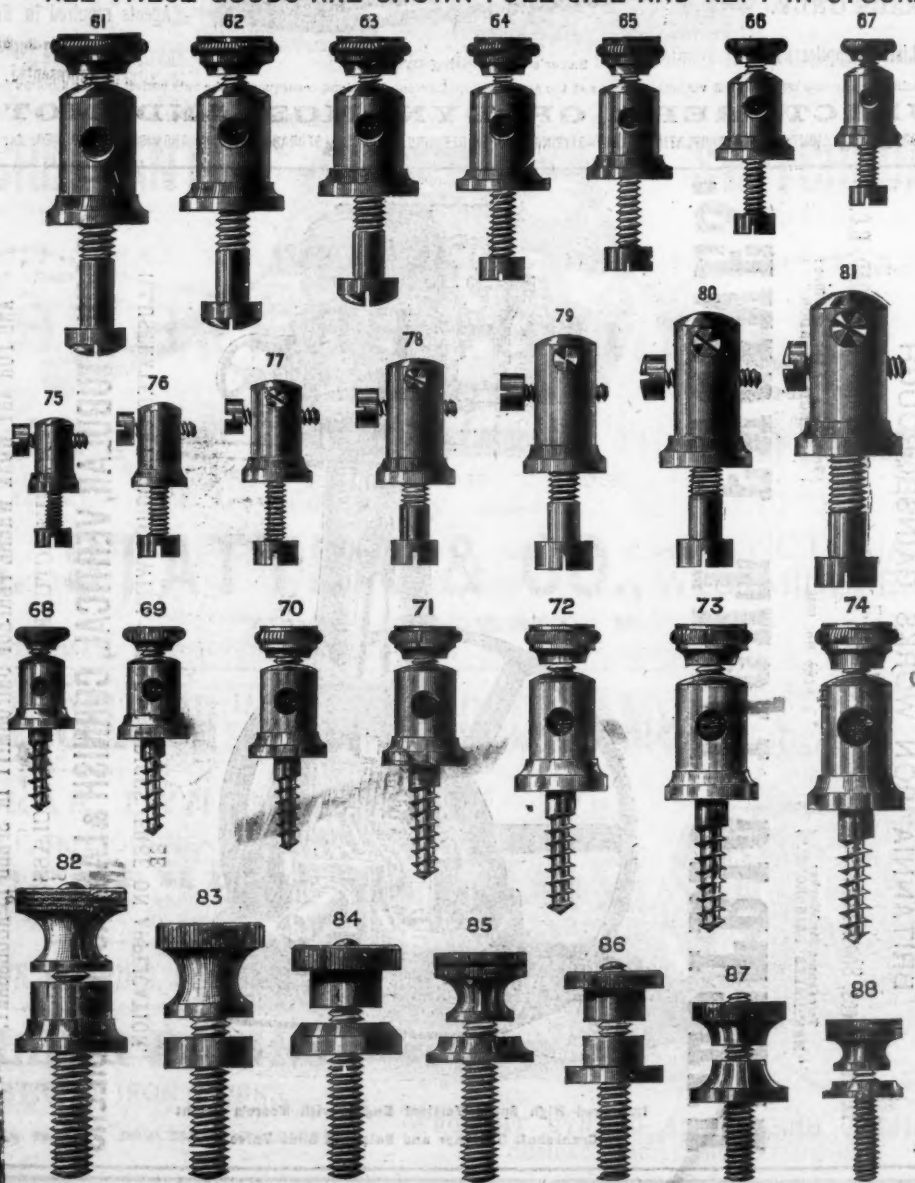
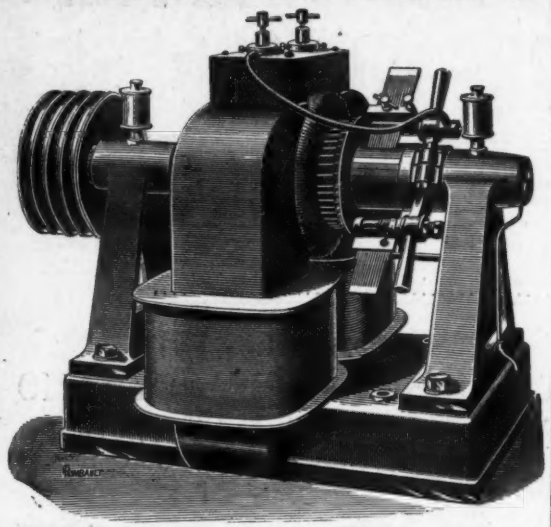


ALL THESE GOODS ARE SHOWN FULL SIZE AND KEPT IN STOCK.



PHŒNIX DYNAMOS



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Makers of
ELECTRIC LIGHT & TELEPHONE APPARATUS
OF EVERY DESCRIPTION.

WRITE FOR PRICE LISTS 202

PHŒNIX DIRECT CURRENT DYNAMOS.

"S" TYPE. MODERATE SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	Approx. Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails and Tightening Screws.	Extra for Fly Wheel for Gas Engine.
						£	£ s.	£ s.
1 S	600	30 to 60	10	1,800	1	20	1 10	2 0
2 S	900	40 to 70	15	1,750	1½	24	2 0	2 10
3 S	1,200	50 to 80	20	1,700	2	28	2 10	3 0
4 S	2,100	50 to 110	35	1,600	3½	38	3 0	3 10
5 S	3,000	60 to 110	50	1,520	5	44	3 5	4 0
6 S	4,500	60 to 110	75	1,430	7½	55	3 15	4 10
7 S	6,000	60 to 120	100	1,360	10	65	4 5	5 0
8 S	9,000	60 to 120	150	1,260	15	85	5 0	5 10
9 S	12,000	60 to 120	200	1,180	20	105	6 0	6 0
9½S	15,000	80 to 150	250	1,100	25	120	7 0	—
10 S	18,000	80 to 150	300	1,020	30	135	8 0	—
10½S	21,000	80 to 180	350	1,000	35	155	9 0	—
11 S	24,000	80 to 180	400	900	40	175	10 0	—
12 S	30,000	100 to 200	500	800	50	200	12 0	—

These prices refer to Compound, Series or Shunt Machines wound to a difference of potentials between the limits given. For those of higher or lower potentials, an additional charge will be made and special quotations submitted.

SERIES DYNAMOS for ARC LIGHTING wound for 10, 15, or 20 Amperes, of Potentials above those given, up to 1,000 Volts.

For the same output, price 15 per cent. over above prices.

PHŒNIX DIRECT CURRENT DYNAMOS.

"D" TYPE. SLOW SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	App ox. Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails.
						£	£ s.
6D	9,000	65 to 110	150	750	15	110	6 0
7D	12,000	65 to 110	200	700	20	130	7 0
8D	18,000	65 to 110	300	650	30	170	8 0
9D	24,000	65 to 110	400	600	40	220	10 0
10D	36,000	110 to 125	600	500	60	290	12 0
11D	48,000	110 to 125	800	450	80	375	14 0
12D	60,000	110 to 125	1,000	400	100	450	16 0

Telephone No. 5422. ESTABLISHED 1870. Telegrams: "Flexible, London."

SILVER MEDAL INTERNATIONAL ELECTRIC EXHIBITION. 1882.

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Electricians,

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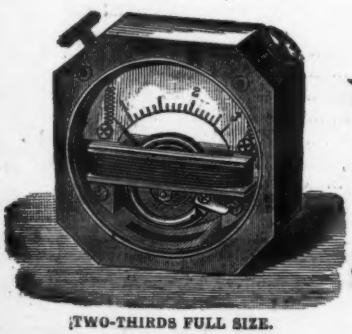
VOLT-METER

FOR TESTING ACCUMULATORS.



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3